# ENGINEERING


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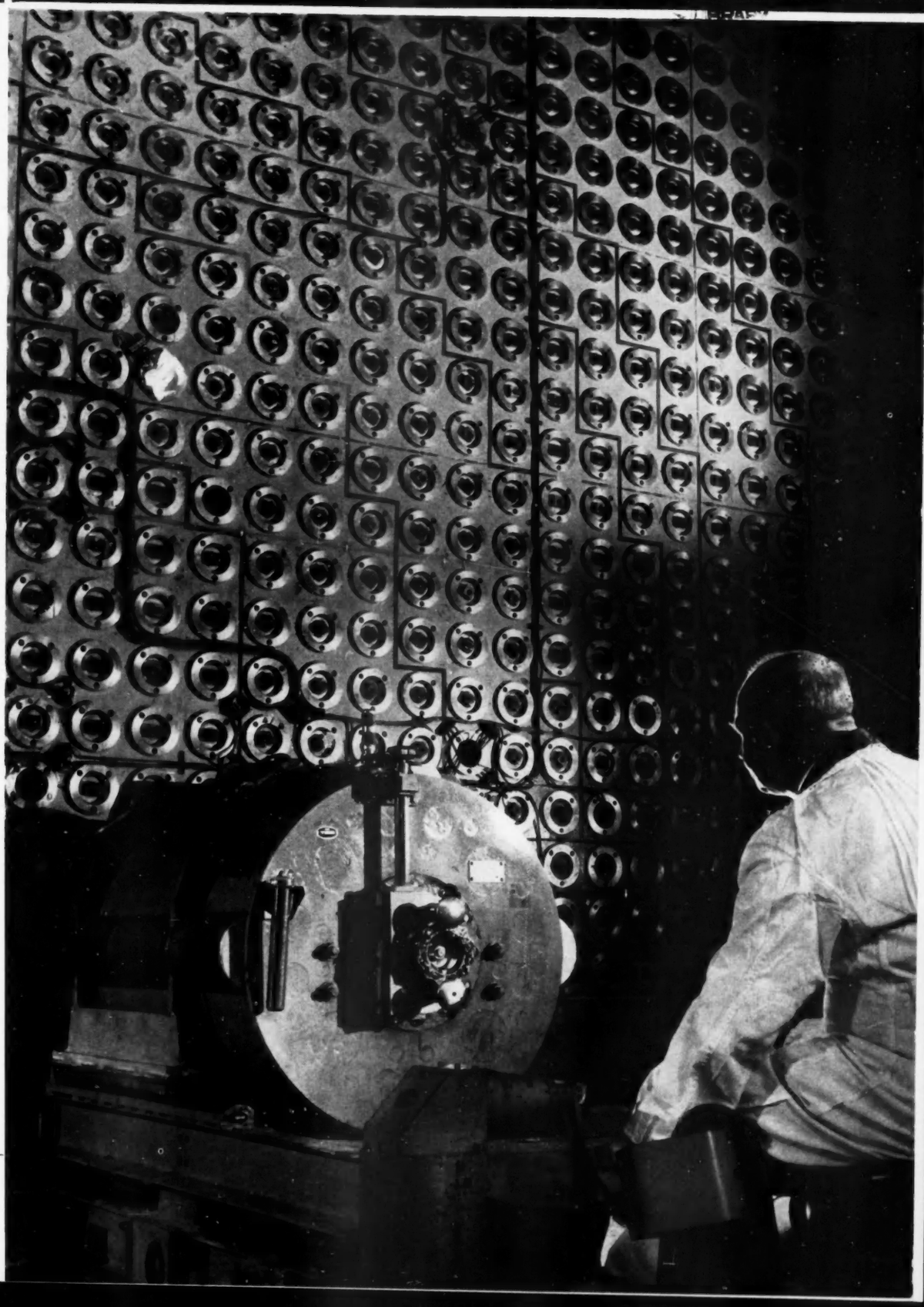


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# Circumstantial Providence

To an engineer, the patchwork of checks and balances which add up to the formulation and practice of economic policy may have all the vices and none of the virtues of Heath Robinson's gadgets. They look to be makeshift, cumbersome and unpredictable in their effect, without being ingenious. Nevertheless the engineer is bound to ask what recent economic measures mean, and how they many affect him or his company.

Those who make economic policy would be the first to admit that the measures which they conceive and put into operation are no more than crude remedies arrived at after an analysis of an exceedingly complex situation. In economic matters, the diagnosis is always more elegant and intellectually sound than the prescription. This is because, when it comes to formulating economic measures, it is exceedingly difficult to assess accurately which factors are relatively most important since laboratory work is ruled out, and it is equally difficult to know how people will react to changing circumstances. Political issues too become involved, and what may from one point of view be an elaborate exercise in economic timing can be equally well interpreted as a cynical estimation of what is politically desirable in terms of the next general election. In economic policy-making, economics and politics are inextricably mixed. Politics is often described as the art of the possible, and on many occasions the need to base economic policy on inspired guesswork makes the economists perfectly happy bedfellows with the politicians.

All these problems are amply illustrated in the current state of the economy. Everyone is agreed that the economic machine in this country is slackening its speed slightly, and that there is some danger that the deceleration might go too far. The Government has, therefore, within the last few weeks abolished hire-purchase controls, ended other aspects of the credit squeeze including limitation of bank advances, and announced as recently as last week that the level of state investment is to be raised by something between £125 and £150 million in 1959-60, above the total of £1,425 million in 1958.

The main economic problem in 1957, and there is general agreement on this, was to defend the pound sterling and to stop inflation. To do this, the credit squeeze was intensified, and a number of economic controls were introduced to discourage capital investment. Of recent years it has always been capital investment rather than expenditure by the general public which has been subjected to alternating checks and stimuli in the interests of economic policy.

It seemed by the early summer of this year that stringency and austerity had gone far enough. The pound was strong; the gold and dollar reserves were rising, even against the normal seasonal trend; the cost of living was stable, and industrial production was beginning to flatten out. It seemed that the time had come to allow industry to re-expand. But there were complications. It was apparent, for instance, that much of the deflationary pressure had been imported from countries abroad which were getting much lower prices for the primary products which they export. It was also desirable to build up the gold and dollar reserves to a much higher level than had operated before the financial crisis of 1957. There were also special circumstances operating as regards exports. There seemed to be a strange delay in the contraction of United Kingdom exports, which stayed remarkably buoyant although the American recession had generated a setback in international trade as a whole. The most surprising development of the summer, was that deflation and inflation seemed to be present in the United States at the same time. Might this happen here?

All these circumstances have enjoined extreme caution on the Government in dismantling economic controls, and made the exercise of timing the changeover from contraction to expansion exceedingly intricate in 1958. It has been deliberately piecemeal. The effect so far has been to release the capital goods industries from controls and to encourage expansion in the home market. The measures taken to stimulate consumer purchases are expected to have a fairly quick effect. The measures taken to stimulate capital investment are expected to provide a "follow-through" in 1959. They are also expected to stimulate private investment by industry in 1959.

In this programme of gradual stimulation, the engineering industry may yet play a vital role. If the engineering concerns as a group begin to hold larger stocks quickly, they will stimulate recovery in the home market to a significant degree. Contrariwise, if they delay, recovery is also likely to be delayed, for the engineering industry is the largest holder of stocks of raw materials and semi-finished goods in the country The remaining unknown factor over which neither engineers nor politicians have any control is the trend of exports. The Government can stimulate the home market, but it cannot force the black man, or any other foreigner, to carry the white man's burden.

**Cover Picture.**—*Spent fuel withdrawn from a nuclear reactor is dangerously radioactive and must be handled with great care. A container, or coffin, encased in lead to absorb the radiation, is shown at the anode face of the Harwell research reactor BEPO, from which highly irradiated fuel rods are being unloaded. Radioactive isotopes can be extracted from the irradiated elements.*

(*Nurnberg photograph for* ENGINEERING)

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# Plain Words

On my way to work one morning, I was surprised to see a tall, rather striking looking man, standing at the kerbside with his hand raised in a salute. With a dramatic gesture to the driver of the bus I was travelling in, he cried, " I admire you for your efficiency, London Transport ! " The passengers all turned to one another with shrugs or smiles, while the driver slowly shook his head and exchanged a grin with the conductor. But the quickened chatter soon died away and I found myself thinking that this unusually appreciative member of the public might not have been so crazy as he seemed.

Maybe it's the rest of us who are crazy—quick as we are to find fault, yet reluctant to applaud. Our affairs would run so much more pleasantly if our generous impulses and our feelings of approval were not so often crushed by the taboos and pressures of our times. The spontaneous compliment is almost always lost in a welter of other calls upon our time and energy, and the appreciative instinct atrophies for want of exercise. The indignation that prompts a letter to the management (or to *The Times*) is seldom complemented by a charitable urge.

We write our formal thank-you's, convey our official gratitude, but rarely are they blessed with spontaneity. We may often feel satisfaction when a contract has been carried out beyond the written requirement, but by the time our secretaries are ready with their notebooks, the momentary warmth has passed. Maybe we should always endeavour to compose our letters on the spot. I received a letter the other day from the representative of a company, written in the sender's own handwriting—possibly it wasn't written on the spur of the moment but it certainly gave that warm impression. But more often than not our attention dwells on the deficiencies rather than the virtues of the service.

I suppose it is the same in our contacts with our colleagues. We should let our approval be known at the moment we feel it. Every manager knows that a compliment here and there oils the wheels; but there is not much joy when you realise that you're just being gently lubricated ! My boss, to his credit, finds it difficult to give praise unless he actually feels the impulse to do so.

I know a man who has made it his hobby to send complimentary letters to companies, civil servants, associations and private individuals, whenever he felt they had done a good job. Possibly he is a bit crazy too: life is just not long enough to have mutual admiration societies springing up all over the place. But it is a kind of madness we could do with a little more of.

CAPRICORN

## Weekly Survey

# *Promoting the Profession*

Professor A. J. S. Pippard, F.R.S., the new President of the Institution of Civil Engineers, entitled his Address " The Individual, the Profession and the Institution " and addressed his remarks primarily to the younger Corporate Members, Graduates and students. In discussing the place of the Institution in the profession he stressed the need to avoid thinking of it as a protective society rather than as a professional and learned body. He pointed out that while the Institution rightly insists on certain educational standards as a condition of Corporate Membership, no diploma is required in this country to practise the profession of civil engineer and—in contrast to North America—no steps have been taken by the Institution to make the profession a closed one.

He pointed out, however, that whereas before 1939 only about half the entrants to the Institution possessed University degrees or the equivalent, the ratio is now over three-quarters, and that in the near future qualification by degrees or diplomas is likely to become the rule for all but a very small minority. For this reason, one of the most urgent and responsible professional duties of the established engineer is to provide the practical training for younger members.

The Address also covered the controversial question of the relationship of professional conduct and publicity, though the President laid the main emphasis on the proper advertisement of the profession as a whole rather than on the advertisement of the individual. He drew attention to the difficulty of arousing the interest of the general public in great works of construction, and attributed this to the fact that descriptions of engineering works which found their way into the non-technical Press are too often written in a style which has little chance of attracting general notice. While it may not be necessary to go as far as the American reporter who summarised the report of the committee which investigated the disaster to the R38 in the headline " R38 Disaster: the tail wagged the dog and broke its ribs," encouragement of this type of imaginative writing may be well worthwhile in presenting engineering achievements to the general public.

## *Credit Due to Aircraft*

The extended credit facilities which can now be offered to overseas buyers of British aircraft will be welcome. The Government is to permit the Export Credits Guarantee Department to insure up to seven years' credit on large British airliners and civil aero-engines, instead of up to five years as permitted hitherto. The United States Export-Import Bank has been granting seven years' credit for large turbojet airliners, and it has been suggested that similar facilities may also be granted for turboprop airliners such as the Lockheed Electra.

In making this announcement, the President of the Board of Trade stressed that this was an exceptional step and that Britain was as unwilling as ever to start a credit race in regard to any particular exports. The aircraft industry is in a particularly delicate transition stage. Its future must depend very largely on a considerable increase in exports. The current steadily rising level (an annual rate of £155 million so far this year) gives little clue to the position in two or three years time, since overseas orders for the next generation of aircraft have been slow to come. There is no reason to doubt the energy of the British sales effort abroad, but several factors make the present world market particularly difficult. Profit margins in airline operation are lower than ever, and the expansion in airline traffic has been lower than expected. Very heavy purchases of new equipment are in course of being made—the bulk being American aircraft. American manufacturers have been able to offer better credit terms, and, backed by a large home market and a high level of military production, in some cases lower prices. At the same time, competition is now by no means confined to America, and will almost certainly become stronger.

The British manufacturers are now investing very large sums in the private development of such aircraft as the de Havilland 121 and Vickers VC 10, which cannot possibly be recovered without significant exports. Lack of adequate credit facilities has frequently been canvassed as a barrier to new orders, and the new measure should certainly help.

## *Value for Money*

Faced with the high cost of shipbuilding in the United States, the Naval Department Bureau of Ships set up in 1954 a Value Engineering Department whose object was to ensure " more ships for less dollars." Some idea of the high costs with which they were faced can be obtained from the fact that tanker construction costs range from $100 to $150 per deadweight ton in Japan, through $200 per deadweight ton in Europe, to as much as $300 per deadweight ton in the United States.

The value engineering programme appears to have grown out of a scheme of value analysis which was established by the General Electric Company of America. The basic philosophy behind this programme appears in the words of a representative of GEC to be that the average design engineer is of necessity obliged to think in terms of performance. The point at which the value of increased performance is nullified by higher cost is frequently lost sight of. The belief is that " performance engineering " and " value engineering " can be regarded as entirely separate functions.

Some indication of the success of this programme was given in a symposium on the subject at the annual meeting of the Society of Naval Architects and Marine Engineers in New York this week. Value engineering units have been established in the 11 United States naval shipyards with from three to six engineers in each unit; they are at present stated to be producing ideas resulting in savings of more than $4·5 million a year, with operating expenses of about $200,000. Many of the ideas are also resulting in specification changes with a long range effect on ship costs.

Reduced to its simplest terms, once a " performance engineering " unit has established that a job can be done, the task of the " value engineer " is to see whether the same job can be done more cheaply. The approach would seem to be of particular use in defence production, normally remote from the force of price competition, and deserves serious consideration on this side of the Atlantic.

## *Trouble on the Tracks*

British Railways' estimated deficit of £85 million for 1958 is attributed primarily to the sharp setback in the output and traffics of coal, steel and other basic industries. While the Government have intimated that they are prepared to advance the necessary funds under the Transport (Railway Finances) Act 1957 on the grounds that the deficit is to a large extent due to external causes, the Minister of Transport has warned that continued repetition would impair financial discipline and confidence in the financial future

of the Railways. The 1958 deficit will bring the total borrowing under the 1957 Act up to over £200 million and it seems very probable that the Transport Commission's borrowing powers of £250 million will be exhausted during 1959.

The chairman of the Transport Commission has pointed out that the Commission must meet the fixed interest on transport stock in full each year, and that there is no equity capital which can go insufficiently rewarded or unrewarded in a bad year, and it has not been possible to build up a general reserve for use in an emergency. It was, of course, to meet this situation that borrowing powers were granted, and it would seem that the only solution to the present dilemma will be an increase in these powers, coupled with a speeding up of the modernisation plan. When the rate of modernisation was cut it was pointed out that speed in completion of the work was a vital necessity, since the longer modernisation is delayed, the more traffic will be diverted from the Railways. The Commission's report to the Minister states that nothing has happened to stultify the appreciation of the future prospects of the Railways as they were set out in the 1956 White Paper, but the urgency of proceeding with modernisation as rapidly as possible remains. Fortunately the present economic climate is such as to permit a speeding up and it is to be hoped that if economy again becomes the order of the day some means will be found of preventing a cut in capital expenditure.

## *Railway for Sale*

When it comes to railways, the child is very much father of the man. A sentimental attachment to railway engines is one of the relics of boyhood which many men carry with them throughout their lives. The closing of railway lines and the scrapping of locomotives can arouse strong emotions in middle-aged cynical men. This may yet prove to be the case in Cumberland where commercial good sense, village self-interest and adult sentiment are locked together in deciding the future of the small railway which runs from Ravenglass along the valley of Eskdale to Dalegarth. The railway's assets, which include two steam engines, three diesels, some open passenger carriages and the services of 12 men, have been offered for sale by the Keswick Granite Company for £22,500. The company acquired the railway some time ago although it was built back in 1876 to transport iron ore and later converted to a 15 in gauge line for transporting slate.

The villagers are worried that the railway will be bought and its assets sold off. The Keswick Granite Company is naturally concerned with the profit and loss aspect of the situation. Schemes have been aired for the village to take over the railway but none of the villagers have any money. One of the drivers has phlegmatically told a newspaper reporter that he did not mind what happened to it provided the Americans do not buy it and ship it across the Atlantic. Probably in the end only sentiment can save the railway as a going concern and few people can afford to be sentimental to the tune of £22,500 in this age of unsentimental tax collectors.

## *Life of a Combine Harvester*

For a variety of reasons the contribution which universities can make to agricultural economics is greater than they can make to industrial economics. Reading University has a specially close connection with agriculture and a recent paper by A. H. Gill "Notes on the life and use of certain farm machines" (Miscellaneous Studies No. 14) is of practical value.

They cover four machines; combine harvester, pick-up baler, manure spreader and tractor, and, for a good sample of farms (mostly in Hampshire, Oxfordshire, Berkshire and Warwickshire) seek to determine such figures as working life, measured both in acres and years and hence, given purchase price and trade-in value, average depreciation per acre. This figure, hitherto somewhat foreign to the thoughts of most farmers, has similarities to the machine/hour rate (including depreciation and overheads) used in many machine shops. As a practical example, if 2,000 acres is taken as a reasonable estimate of the working life of a self-propelled combine, £1,700 as the present day purchase price and £200 as the trade-in value, depreciation would amount to 15*s* per acre. Similarly for balers, corresponding figures might be 2,500 acres, £800, £200 and 5*s* per acre (or say 1*d* per bale).

The notes contain quite a lot of interesting incidental information, for example that reliability was the main factor governing decisions regarding replacement. If a machine was found to be reliable it was retained long after some of its features were obsolete and faster machines had become available. A full-time mechanic was employed on 14 per cent of the farms in the sample and in a further 25 per cent there were facilities for all except major repairs.

There is, however, one very big omission, possibly owing to the difficulty of getting information, and that is the degree to which capital was available to the farmers in question. Even if two farmers have the same acreage and the same available capital one will spend capital and the other will not. One will take every opportunity open to him in the form of agricultural mortgages and hire-purchase terms, and the other will not. One will buy new machinery because he likes to see it around and the other will hang on to his old machines long after he has written them off and better ones are available. In other words, human attitudes rather than economics play a very big part in determining the rate at which machinery is replaced. Reading University has, however, done a useful job in collecting some of the facts.

## *Freedom and Order*

Any extension of state ownership in industry would bring positive harm to industry, and would undermine the foundations of its efficiency. This is the main conclusion reached by the Federation of British Industries in their *Report on Nationalisation* published this week. The basis for this view is the belief the FBI have in the system of free enterprise, which, they write, is "an efficient system because it gives men the incentive to seek progress through more efficient ways of doing things; at the same time it subjects them to the pressure of competition from others who seek the same ends." The elements of competition—the will to take risks and the high rewards for the successful—the FBI consider a *sine qua non* of economic progress. The whole system is "built on the recognition of the importance of the individual" and everything should be done to foster his self-reliance and dynamism.

The FBI point out that the record of nationalised industries leaves much to be desired: they have taken a more than proportionate share of the total funds used for investment in the economy, and "there is no conclusive test by which to determine whether this has been justified." They have not produced any discernible improvement in labour relations. They have not made proper provisions for depreciation and can lay no claim to outstanding progress, technical or organisational. The report attacks the proposals made in the Labour Party's new policy statement *Industry and Society*, which advocates the renationalisation of steel and long-distance road haulage, the nationalisation of any industry found to be "failing the nation," and the State acquisition of equities in other industries. Likewise examined are the proposals put forward in a further policy statement, *Plan for Progress*, for the special supervision of the investment programmes of large companies and the establishment of a National Investment Board to keep investment policies under permanent review.

The FBI report is of necessity a very condensed document (68 short pages) and does not attempt a detailed analysis of the experience obtained since the war in the operation of nationalised industries. Nor does it tackle the subject of industrial planning—advocated by many leading Tories. Within these limits it hangs fairly convincingly a string of arguments on the line that man should be free within the compass of his own understanding and driving force.

# TELESCOPE *for the* STRATOSPHERE

*"Astronomical Measurements with Rockets, Satellites and Balloons" was the subject of a talk given recently to the British Interplanetary Society by Dr. A. P. Willmore of the High Altitude Research Group of University College, London. The main points are summarised below.*

The entire band of ultraviolet and soft X-ray radiations, which give much information about the structure and constitution of the sun and the universe in general, is not detectable until a telescope or camera is raised by rocket or satellite to 100 to 150 km or more; the X-ray spectrum has only become measureable by using high altitude satellites to carry instruments. The turbulent atmosphere in the troposphere also makes difficulties in observation by visible light. Above about 10 km, the air is fairly smooth and stratified, and by placing a telescope here much better "seeing" is obtainable. In 1957 Spitzer and Swartzchild, supported by the US Office of Naval Research and the US Air Force Office of Scientific Research, flew to 80,000 ft a balloon-carried telescope with the name "Project Stratoscope." The balloon was a 200 ft long "Skyhook," made of polyethylene film. The telescope was fitted with a 12 in diameter f/8 paraboloidal quartz mirror as the primary element, the secondary element being another quartz mirror mounted, in the Newtonian position, on a swinging arm so that it remained in the sun's image only long enough to give a photographic exposure; this prevented the secondary mirror from getting burnt. To take account of thermal distortion a 25× "relay" lens was placed in the optical system. This increased the effective focal length of the telescope to 200 ft, and was moved to and fro in the primary image field to make sure that 5 per cent of the photographs taken would be in focus; recording was done with a 35 mm camera which scanned the image of the sun's disc and took 4,000 frames in each flight, so that at least 200 perfectly focused frames were obtained, forming a composite picture of the sun. The telescope, which was fitted with a photo-electric device to keep it aimed at the sun, weighed about 300 lb and was recovered by parachute.

Analysis of "Stratoscope" pictures showed that, with 90 per cent of the atmosphere below the telescope, the definition was about five times better than the best achievable from the ground, and turbulence cells in the sun's atmosphere of only 200 miles across could be resolved. If the difficulties associated with making aiming devices lock on to much dimmer objects can be overcome, telescopes like Stratoscope will be of great value in studying the topography of the planets, Mars in particular. The increase in resolution should answer many questions about the Martian surface, vegetation, and climate.

*Questions and Answers from Jodrell Bank*

# TRACKING LUNAR PROBES

The following notes—in question and answer form—have been issued by the Jodrell Bank Experimental Station. They discuss the problem of tracking lunar probes by means of the radio telescope.

*How soon after lift-off is it possible for the radio telescope at Jodrell Bank to pick up the signals from a lunar probe?*

As soon as it appears above the horizon. The time depends on the orbit into which the probe is fired. In the case of Pioneer it was 10 minutes.

*How are the signals received in (a) the USAF trailer? and (b) the Jodrell Bank control room?*

On magnetic tape and pen recorder paper charts. Audio monitoring on loudspeaker, if necessary.

*What sort of signals are being received—what information do they convey?*

The beacon signal, which is used for determining the position of the probe. The modulated signal, on which is impressed the scientific data collected by the experiments in the probe. This is the telemetery.

*Are the scientists at Jodrell able to interpret these signals?*

Yes. For the experiments in which they have a particular interest, they have the preliminary calibration data from workers in the United States. Of course, the full analysis is a lengthy task requiring an assessment of all the data collected. The publication of these results will be carried out in due course in the normal manner by the scientists responsible for the individual experiments.

*How are they passed back to the United States?*

The position of the probe as determined by the telescope is sent back by teletype continuously. The telemetered signals on the magnetic tapes are sent back by air. A duplicate set is retained at Jodrell Bank.

*What is the immediate function of the computing centre at Los Angeles?*

To collect the positional data from Jodrell Bank and the other tracking stations and from this to calculate the orbit of the probe and predict its future course.

*Can the course of the rocket be accurately estimated at Jodrell both in terms of distance and direction?*

The co-ordinates of the probe in the sky are determined to one-fifth of a degree by the telescope. The distance is not measured directly but can be inferred from the orbit.

*How is the position of the probe calculated so that it may be picked up quickly on succeeding days when it rises above the horizon?*

The orbit is calculated in advance. If the probe departs from the intended orbit (as in the case of Pioneer) corrections have to be assessed by the computers. In an extreme case, the telescope could search all possible sky positions in an hour or so, as was done on the last morning of Pioneer.

*How does the telescope keep tracking the rocket? Is it moved automatically to follow its flight? Who instructs the controller on what to do?*

The telescope is moved so that the signal in the control room is maintained at its maximum. The precise position of maximum is determined every ten minutes by sweeping the direction of the telescope around the position of the probe. The minute-to-minute instructions to the controller are given by the Jodrell Bank scientists in charge of the pen recorder in the control room.

*At what distance, if at all, would a probe leave the earth's gravitational field?*

Never. All bodies in the universe are under the influence of one another's gravitational field. However, this weakens as the inverse square of the distance and another massive body (e.g. the moon) may exert a dominating influence when the probe gets close enough.

*If a probe went on past the moon, what is likely to happen, or what could happen?*

It would either eventually come back to earth, or become a satellite of the sun. It may temporarily come under the predominant influence of the gravitational field of a planet, and would then make one pass near it.

*What value are these experiments to radio astronomy?*

Several of the experiments in the probe are directly connected with the interests at Jodrell Bank. For example, the micrometeorite experiments will link up with other meteor measurements which are in progress at Jodrell Bank (also in co-operation with the United States). The determination of the radiation field, the magnetic field, and of the cosmic-ray intensity as the probe moves out of the atmosphere are also of vital importance to the interpretation of other aspects of the work at Jodrell, particularly work on solar terrestrial relationships. The propagational conditions between the probe and the earth are also a part of Jodrell Bank's normal work.

*What speed must it attain at lift-off in order to reach the moon?*

This depends on the precise orbit and on the reserve energy in any terminal rockets (retro-rockets). It will be about 25,000 m.p.h. The lift-off speed of earth satellites is about 18,000 m.p.h.

*What is an eccentric orbit?*

If two bodies move round one another under their mutual gravitational fields (e.g. the planets around the sun) the general form of the motion is an ellipse. Nearly circular motion is a limiting case, and all elliptical orbits are "eccentric." The eccentricity is a measure of the ratio of the major and minor axes of the ellipse. Thus, a very eccentric orbit is an elongated ellipse. Apogee is the most distant point of the orbit, perigee the nearest.

*In an eccentric orbit, what determines whether it will hit the earth or whether it will continue in orbit?*

At the closest approach (perigee) the satellite moves into the earth's atmosphere. The question as to whether it will come to earth immediately or continue in orbit for a long time, depends very critically on this perigee distance, because the density of the atmosphere decreases very rapidly with height. The critical perigee distance is about 100 miles.

*Will the rocket rise earlier each day? If so, how much earlier?*

When near the moon its time of rising and setting will be similar to that of the moon. During passage, no general answer can be given, since this depends largely on the nature of the orbit into which the probe is fired.

*What are the advantages of a narrow beam width?*

Same as a narrow searchlight beam. That is (*a*) greater concentration of power and hence ability to reach greater distances and (*b*) greater accuracy in determination of positions.

*If a lunar probe turns—as it did last time—how can that change be detected by scientists at Jodrell?*

Only by inference from the changes in orbit.

The British team at Jodrell Bank, led by Professor A. C. B. Lovell, FRS, includes: Dr. J. G. Davies, Dr. S. Evans, Dr. John Evans, Mr. John Thomson, and Commander Richard Tolson, DSC.

# MOON MISS

The third United States Air Force moon rocket having failed, the launching platform is now to be given over to the United States Army. However, even failures can be considerable scientific achievements. The second lunar probe vehicle, Pioneer, reached a distance of 79,120 miles from the earth—an altitude thousands of miles higher than any other man-made vehicle had attained—and yielded information on radiation and other conditions in outer space that had previously only been the subject of conjecture. In particular, it showed that the radiation intensity inside its casing at altitudes over 50,000 miles was about 4 roentgens per hour—a level at which it should be possible to provide sufficient protection for a human passenger, although it is above the safety level for an unprotected man.

A further outcome of the Pioneer lunar probe experiment was proof that a satellite could be used as a world-wide communications link: at one point, Manchester and Hawaii were in radio contact via the satellite. The communications experiment worked as follows. The command station at Hawaii sent a signal to the satellite, which on picking it up retransmitted it at a different frequency. The change in frequency was picked up at Jodrell Bank.

No actual messages were sent this way during the test with Pioneer. It would be possible, however, to send pulse-modulated messages in a pre-arranged code. Much remains to be done before a world-wide communications network making use of repeaters in satellites could come into existence, but it has been suggested that this would be a basis for producing an economical world-wide television service. The communication link with Pioneer was accomplished when the satellite was at its highest point. The signal was sent not only from Hawaii to Jodrell Bank, but also from Cape Canaveral to Jodrell Bank and Hawaii.

About 30 lb of instruments were carried by the probe. These were to measure magnetic fields, micrometeorites, radiation intensity, and internal temperature. It has been reported that the last parameter stood at an average value of about 40° F.

Also contained in the honeycomb glass-fibre shell of the probe was a crude infra-red scanning camera, with which it was hoped to observe the major features of the moon's surface. Information from the probe was emitted from a two-limbed aerial extending from its top. This aerial would also pick up a command signal from Hawaii that would fire the "retro rocket," a 50 lb rocket with a thrust of about 3,000 lb. This was also carried by the probe and would be fired if it were necessary to slow down the probe as it approached the vicinity of the moon.

The United States Air Force probes, with their three-stage launching rockets have a total length of 88·1 ft. The first stage is a standard USAF Thor intermediate range ballistic missile, weighing over 100,000 lb and having a thrust of 150,000 lb. The second stage is a modified Vanguard rocket with the addition of 8 spin rockets; and the third stage is an advanced version of the Vanguard using a solid-propellant engine. The second and third stages weigh 4,000 and 400 lb and have thrusts of 7,500 and 2,500 lb.

The United States Army lunar probe will use a Jupiter in the first stage. It was, in fact, an Army Jupiter "C" rocket that put the first American satellite in orbit, and it is thought that as far as the lunar probe is concerned the Army will again have a better chance of success.

**Plant and Equipment**

# *A Review of* BAR AND TUBE STRAIGHTENING MACHINERY

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Round bars and tubes leaving the rolling mill or drawbench are not sufficiently straight to be commercially acceptable. This defect is due to a variety of causes, predominant among which are an unequal heating and cooling of billets, distortion caused by conveying mechanisms and handling, and internal stresses set up during drawing.

Hand straightening, except in very exceptional circumstances, has long been a thing of the past, its place having been taken by machines of widely varying construction, but all fulfilling the essential requirement that the material worked upon must be stressed beyond its elastic limit.

## INTERMITTENT OPERATION

The earliest type of straightening machine was probably the gag press, which does its work by the impact of a tup on the bar or tube at a point midway between two supporting anvils (Fig. 1). It may be of vertical or horizontal construction, the reciprocating tup being operated by a crank and connecting rod mechanism, or by hydraulic means. In either case the stroke can be regulated to accommodate sections of varying depth and to control the amount of permanent set which it is desired to impart. Presses of this kind are still used extensively, and modern types are well designed and constructed. Because of its intermittent action and the dependence of its results on the human element, the gag press is not capable of high rates of output. Consequently, its use is generally limited to rough straightening of badly bent bars prior to putting them through a continuous machine, or to dealing with small miscellaneous batches of heavy material. Nevertheless, in the hands of a skilled operator, the gag press is capable of straightening with considerable accuracy.

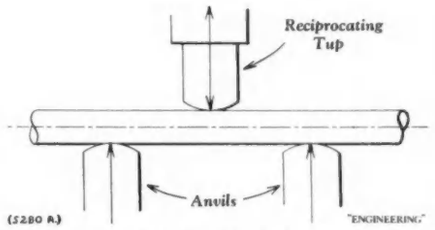



*Fig. 1 Gag press.*

Another intermittent type of machine, which has a wide field of application and makes less demands on the skill of the operator, is the hydraulic stretcher (Fig. 2). As its name implies, this machine straightens the material by stressing it in tension beyond its yield point.

## CONTINUOUS TYPES

For continuous straightening the material is flexed as it passes between rolls, and machines embodying this principle fall into two basic classes:

(*a*) Machines having two banks of staggered rolls mounted on spindles at right angles to the line of pass (Fig. 3). In the usual construction the rolls are mounted on horizontal spindles; those in the bottom bank are driven and those in the top bank are adjustable vertically and horizontally. Machines of this class, with rolls suitably grooved, are sometimes used for straightening round stock, but they are most effective when handling sections other than rounds, and it is for this purpose that they are in general use. The combination of adjustments provided for the top rolls ensures straightening in the horizontal and vertical planes, but in some machines this two-plane straightening is accomplished by following the first set of horizontally-mounted rolls by a second set working on vertical spindles.

(*b*) Machines having two or more rolls arranged on either side of the pass line and oppositely inclined to it; certain of the rolls are driven and thus have the effect of rotating the bar or tube and, at the same time, of propelling it axially through the machine (Fig. 4). This class of machine, with many variations in the number and disposition of its rolls, is now universally accepted for high speed and accurate straightening of round stock.

*Two-Roll Versions*

The first machine of the two inclined roll type seems to have been introduced at least as far back as the turn of the century. The type is still widely used to-day and with rolls of appropriate contour and in some cases of a variable angle of inclination, it is capable of straightening end to end with precision. It is also used for sizing, correcting ovality, descaling, polishing and reeling tubes off mandrels. It is applied to both hot and cold work, but owing to its lesser roll inclination angle (5° to 15°), it is not capable of such high throughput speeds as the multi-roll machines (that is, more than two rolls) of this class, which have their rolls set at a higher angle (25° to 35°). Other things being equal, the straightening speed varies as the sine of the angle. In practice, it ranges from 20 to 80 ft per min, being selected to suit the condition, dimensions and physical characteristics of the material handled.

*Multi-Roll Machines*

The roll arrangements shown in diagrams *b* to *h*, Fig. 4, are examples of the present day

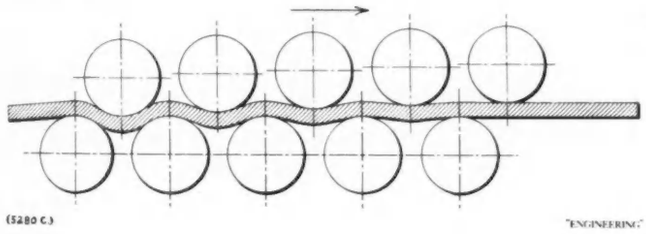



*Fig. 3 (left) Straightening machine with staggered rolls.*

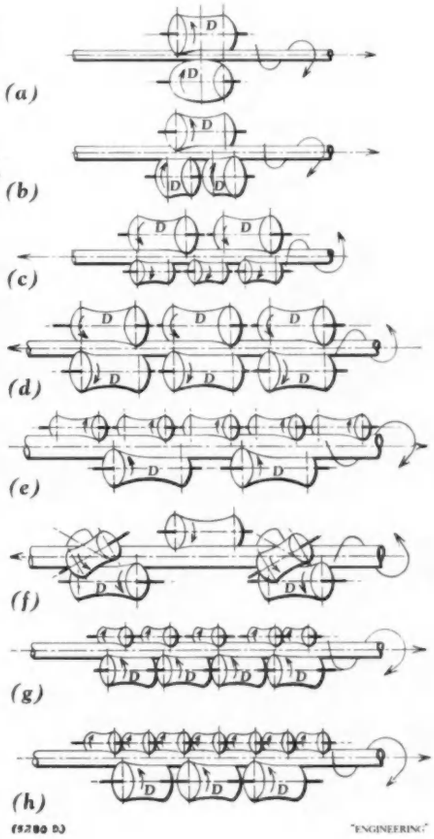
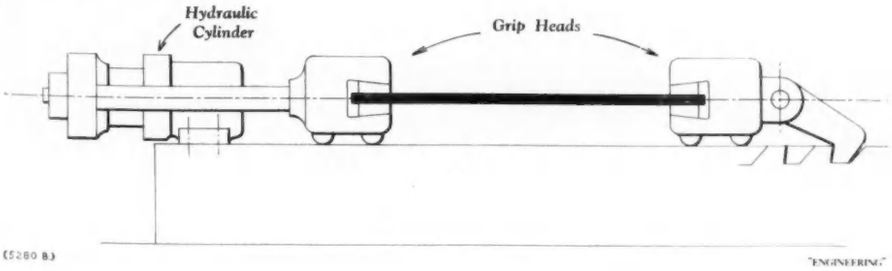



*Fig. 4 Types of multi-roll straighteners. Rolls marked "D" are driven.*

*Fig. 2 Hydraulic stretcher.*



## *Continuing* Straightening Machines

practice of well-known British, Continental and American makers of high speed multi-roll bar and tube straighteners. Throughput speeds of machines in this class vary from 50 ft to 450 ft per min, depending on the size and characteristics of the work to be handled.

All these combinations are descended from a common prototype (*c*., Fig. 4, and Fig. 5) designed by Petter B. Abramsen and patented by him in 1913. It proved to be a very effective machine and in 1921 Joshua Bigwood and Son Limited of Wolverhampton undertook its manufacture under licence in the United Kingdom. Since that time, this firm has introduced a number of variations and improvements of the original design, necessary to meet the increasingly stringent requirements of bar and tube manufacturers. These modifications include: variable angle driven rolls, adjustable driven roll centres, and the provision of five idle rolls (*e*., Fig. 4) for better tube straightening.

The three roll arrangement, *b*., Fig. 4, is an American type designed particularly for straightening tubes. It employs a three point method of straightening and the rolls are contoured so that the work is retained in its proper path of travel without the aid of inter-roll guides. The claims made for it are that it is extremely flexible in adjustment and that it is effective in correcting ovality in welded and other tubular products.

*f*, Fig. 4, shows another American type, the main feature of which is two identical roll clusters situated at the entry and exit ends of the machine, each including two idle rolls and one driven roll inclined to the pass line and spaced round it at approximately 120° intervals; a pressure roll is positioned midway between these groups. The work is thus confined to the pass line and it is claimed that accurate end to end straightening is possible.

The two machines shown in *g* and *h*, Fig. 4, are the products of Continental makers, having nine and ten rolls respectively and are designed primarily for tube straightening.

Many present day machines, like the original Abramsen, are of horizontal construction, that is to say the rolls are disposed on either side of the pass line, but there has been a tendency of late for the vertical machine to be favoured by some makers; in this construction the rolls are placed above and below the pass line. All the multi-roll machines for material other than black bars have rolls of concave hyperbolic contour for line contact. Such an arrangement is shown in Fig. 4, *d*. This has three pairs of rolls, all driven, one roll of each pair being above and one below the pass line.

### ENTRY AND EXIT

Makeshift guides and the man-handling of bars and tubes into and away from the straightener rolls have been responsible for many serious accidents to operators, either by entanglement or by contact with a rapidly revolving and whipping bar. The risk of injury at the entry end is generally considered to be the greater, but a proportion of the accidents have occurred at the delivery end, usually the result of wrong handling methods.*

In the interests of safety and efficiency, properly designed guides with feeder and ejector mechanisms should be regarded as an essential and integral part of straightening equipment. Fig. 6 shows two machines so fitted.

A number of combinations of inlet and exit guides and feeder and ejector mechanisms, recommended for use with various reelers and straighteners, are indicated by code letters and numbers in Table I; the key to these codes is furnished by the symbolic Figs. 7, 8 and 9, and by the following descriptions:

* This subject was investigated by a sub-committee of the accident prevention committee of the British Iron and Steel Federation, which issued a report entitled "The Safe operation of Bar Reeling and Straightening Machines" in 1955.

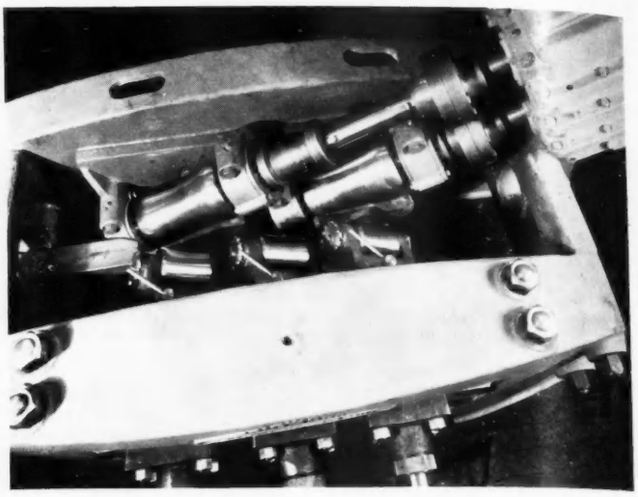


*Fig. 5 Five-roll straightening machine (two inclined driven rolls, three idle rolls).*

TABLE I.—*Tube and Bar Straighteners—Entry and Exit Guides*

| Range of diameters, in | Constant length batches | | | | Random length batches | | | |
|---|---|---|---|---|---|---|---|---|
| | Black bar or tube | | Bright or easily marked bar or tube | | Black bar or tube | | Bright or easily marked bar or tube | |
| | Up to 20 ft and fairly straight | Over 20 ft or badly bent | Up to 20 ft and fairly straight | Over 20 ft or badly bent | Up to 20 ft and fairly straight | Over 20 ft or badly bent | Up to 20 ft and fairly straight | Over 20 ft or badly bent |
| H.S. Bar and Tube Straighteners: | | | | | | | | |
| ½/1¾ .. | ENT1; FM1 EX1; FM1 | ENT1; FM1 EX1; FM1 | ENT1; FM2 EX1; FM1 | ENT1; FM2 EX1; FM1 | ENT1; FM1 EX1; FM1 | ENT1; FM1 EX1; FM1 | ENT1; FM2 EX1; FM1 | ENT1; FM2 EX1; FM1 |
| 2/3 .. | ENT2; FM1 EX1; FM1 | ENT2; FM1 EX1; FM1 | ENT2; FM2 EX1; FM1 | ENT2; FM2 EX1; FM1 | ENT2; FM1 EX1; FM1 | ENT2; FM1 EX1; FM1 | ENT2; FM2 EX1; FM1 | ENT2; FM2 EX1; FM1 |
| 3½/5 .. | ENT3; FM1 EX1; FM1 | ENT3; FM1 EX1; FM1 | ENT2; FM2 EX1; FM1 | ENT2; FM2 EX1; FM1 | ENT3; FM1 EX1; FM1 | ENT3; FM1 EX1; FM1 | ENT2; FM1 EX1; FM1 | ENT2; FM2 EX1; FM1 |
| 4/12 .. | ENT3; FM3 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM2 EX2; LR |
| 7/18 .. | ENT4; FM2 EX3; LR | — | ENT4; FM2 EX2; LR | — | ENT4; FM2 EX3; LR | — | ENT4; FM2 EX2; LR | — |
| Reelers: | | | | | | | | |
| ½/2 .. | ENT1; FM1 EX1 | ENT1; FM1 EX1 | ENT1; FM1 EX1 | ENT1; FM1 EX1 | ENT1; FM1 EX1 | ENT1; FM1 EX1 | ENT1; FM1 EX1 | ENT1; FM1 EX1 |
| 2½/4 .. | ENT2; FM1 EX2 | ENT2; FM1 EX2 | ENT2; FM1 EX2; LR | ENT2; FM1 EX2; LR | ENT2; FM1 EX2 | ENT2; FM1 EX2 | ENT2; FM1 EX2; LR | ENT2; FM1 EX2; LR |
| 4½/13 .. | ENT3; FM1 EX2; LR | ENT3; FM1 EX3; LR | ENT3; FM3 EX2; LR | ENT3; FM1 EX2; LR | ENT3; FM2 EX2; LR | ENT3; FM1 EX2; LR | ENT3; FM1 EX2; LR | ENT3; FM1 EX2; LR |

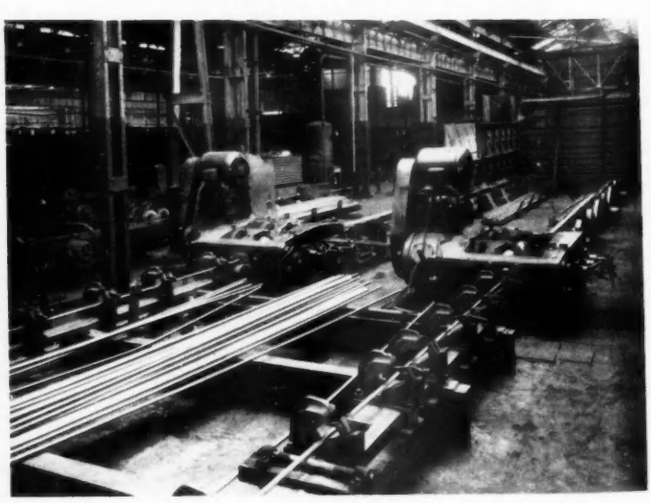
### *Entry Guides, Fig.* 7

Types ENT 1 and 2: The trough is furnished with a simple means of vertical and lateral adjustment; the hinged top cover is operated by means of a double-acting pneumatic cylinder, the action of which is co-ordinated with that of the feed rolls, in that they cannot grip and feed the stock until the cover is locked in the closed position, or re-open until the stock has cleared the machine. The guide must be lined with a non-abrasive material when damage to the surface of the stock is to be avoided. A bell-mouth guide should be included between the feed rolls and the machine, located as close as possible to the straightening rolls. An acceptable alternative to Type ENT 2 is a channel with flat-hinged top cover.

Type ENT 3: This consists of a bed of channel and plate construction, as shown in the diagram with graduated "C" guides (flame cut plate or steel castings) and raising and lowering support rolls spaced along it. The guides are lined with non-abrasive material where necessary. The means of adjustment and the operation of the cover and feed rolls are as in the case of ENT 1 and ENT 2.

Type ENT 4: A more expensive construction

*Fig. 6 Two multi-roll tube straightening machines.*



for use with the larger machines consists of a number of "U" shaped trough sections fitted with latches which permit stock to enter the guides, but prevent it from whipping out during straightening. Between each guide section is a horizontal supporting idle roll which is lowered —hydraulically or pneumatically—clear of the bottom of the trough as soon as the stock has entered the machine.

*Feed Mechanisms, Fig.* 8

Type FM 1: In this case stock is fed into the straightener by means of a pair of pinch rolls, profiled as shown in the diagram, rotating on a horizontal axis at right angles to the line of pass. The bottom roll is driven and is adjustable for height, whereas the top roll is idle and is raised or lowered by pneumatic cylinders, so that the stock is given clearance or is gripped and conveyed into the straightening rolls. One side of the rolls must be left clear to permit stock rolling into the guides to take up its position between them. The rolls may be made of cast iron and, where necessary to prevent marking of the stock, they may be hard-rubber covered, or made from a non-abrasive material.

Type FM 2: The feeder shown in this case consists of a pair of cross rolls (one driven), slidably mounted at right angles to the line of pass, each roll assembly being connected to a hydraulic or pneumatic cylinder. The stock is dropped into the trough with its leading end projecting between the feed rolls. One of the rolls, by means of its operating cylinder, is brought up against an adjustable stop which is set to ensure that the material being straightened is located in the right line of pass corresponding to its diameter. The other roll is then brought up so that the stock is firmly held between rotating rolls. It is thus revolved and at the same time fed forward into the straightener. As soon as the leading end of the material is gripped by the straightening rolls, the feed rolls are brought back into their retracted position.

Type FM 3: In this case the stock is pushed into the straightening machine by means of a ram operated by a pneumatic or hydraulic pressure cylinder. The hydraulic cylinder must have sufficient length of stroke to compensate for stock of varying lengths, or it may operate indirectly by a pusher mandrel.

*Exit Guides, Fig.* 9

Type EX 1: This is a simple type of exit guide consisting of two angles, one forming a run-out table and having its bottom leg slightly inclined to the horizontal, while the other leg forms the stop against which the stock, by virtue of its direction of rotation, presses as it emerges from the straightener. The other angle forms a hinged cover which is pneumatically-operated and, when opened, permits the straightened material to roll out on to the receiving rack. An adjustable plough plate should be included to deflect the bar from the table. Where necessary, the inside faces of the guide should be lined with non-abrasive material.

Type EX 2: This is intended for medium size machines; it is similar in principle to the one previously described, but the straightened stock is supported on retractable rolls spaced along its length. These rolls are, of course, in the raised position while the material is emerging from the machine, but as soon as it has cleared they are lowered, the cover is opened and the stock rolls down the inclined table on to the receiving rack.

Type EX 3: This type is suitable for very large machines; it has driven or idle horizontal supporting rolls and inclined side rolls. The stock is removed from the guides by ejector levers, not shown in the sketch. Guides of this type should be fenced with hand-rails and wire mesh as a safeguard against accidents.

Type LR: these code letters signify live support rolls, and in such cases pinch rolls need not be included.

## OPERATION SEQUENCES

(*a*) Open cover to inlet trough and enter stock.
(*b*) Close cover and close feed rolls on stock.
(*c*) Open feed rolls as soon as stock has entered straightening rolls.
(*d*) Close ejector rolls on stock as soon as it clears straightening rolls.
(*e*) Release ejector rolls and open exit guide cover.

(*a*), (*b*) and (*c*) are usually initiated by push-button or hand-controlled air valves. Where the straightener includes idle rolls, operation (*c*) may be carried out by a centrifugal switch on the first idle roll which causes the feed rolls to open as soon as the idle roll is running at speed. Similarly, a centrifugal switch on the last idle roll can be used to close the ejector rolls.

Alternatively, (*d*) and (*e*) may be performed by a flag switch between the last straightener roll and the ejector rolls, which close when the trailing end leaves the straightener; an electrical timer, or other device, must be included to delay the opening of the exit guide cover until the stock is in position for ejection.

The recommendations contained in the above are to be regarded as a general guide to the selection of suitable equipment, although special considerations may make it necessary to vary the combinations of the components described.

## BASIC PRINCIPLES

All roller type straightening machines owe their effect to the fact that the material worked upon is deflected, as it passes through the machine, by bending moments of sufficient magnitude to produce stresses in the plastic

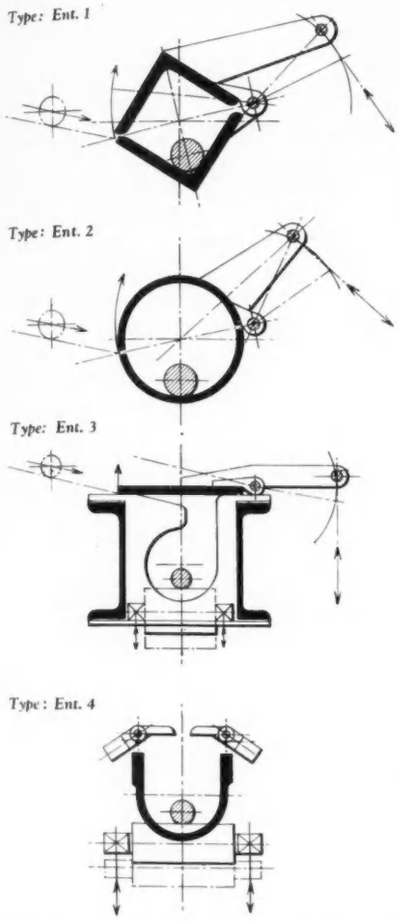



*Fig. 7 Entry guides.*

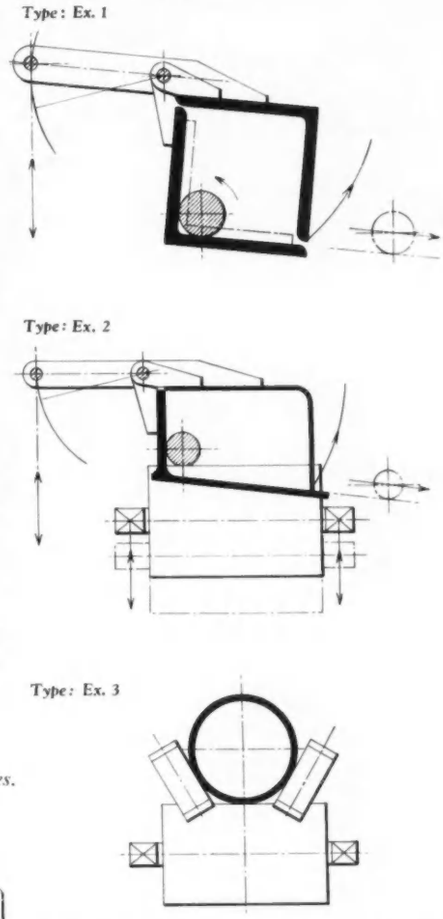
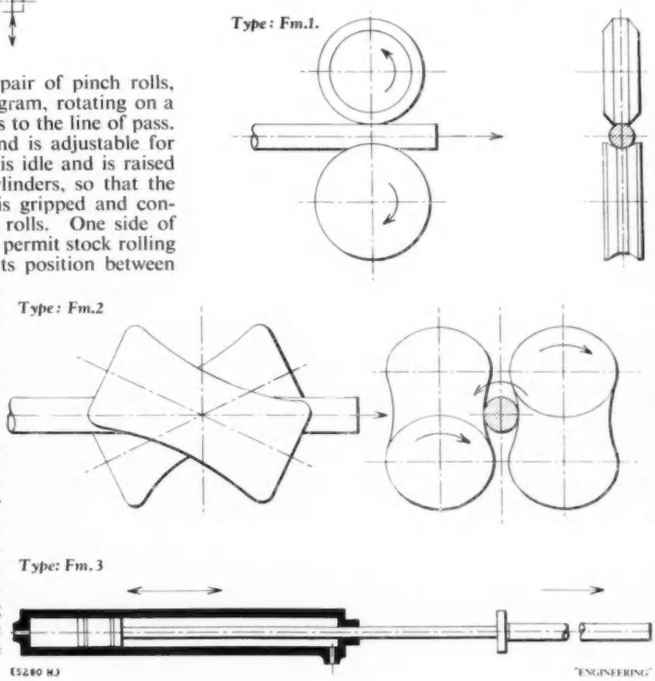



*Fig. 9 Exit guides.*

*Fig. 8 Feed mechanisms.*

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## *Continuing* Straightening Machines

range over a considerable proportion of the depth of the section measured from the extreme fibres. While the material is in this state of stress, its direction, controlled by roll adjustment, ensures the rectification of original deviations.

For the straightening of rounds, the advantage of the inclined roll machines over other types lies in the fact that the material rotates as it travels in an axial direction and is thus subjected to uniform depth of stress around its circumference, as well as uniform working over its entire surface, provided the roll angles and lengths of contact are correct.

The forces applied by the rolls are determined by their dimensional layout and by the shape and size of the cross-section of the material and by its stress-strain characteristics.

The dimensionless stress-strain curve for the section under consideration is a useful aid to the calculation of straightening loads, as such a curve shows the relationship between the ratio of the actual bending moment (M) producing inelastic strain and the bending moment ($M_y$) which just produces yield stress in the extreme fibres and the ratio of the strain, $\epsilon$, produced by the moment (M) to that, $\epsilon_y$, produced by ($M_y$); the $\left(\frac{\epsilon}{\epsilon_y}\right)$ scale can be supplemented by one showing the depth of plastic yield,

$$a = R\left(1 - \frac{\epsilon_y}{\epsilon}\right)$$

where $a$ = depth of yielding measured from outer fibre,

and R = outside radius of bar or tube.

The moment-strain curve flattens out at a limiting value corresponding to full yield. In the case of solid round bars this value is 1·7 and in the case of tubes it varies from 1·65 to 1·35 for thick and thin walled tubing respectively.

$$\text{For a value of } \frac{M}{M_y} = k$$

$$M = \left(\frac{M}{M_y}\right) M_y = k\sigma_y Z$$

Z being the section modulus and $\sigma_y$ the yield stress. $\sigma_y$ may be in excess of the static yield if the rate of stressing is such that the dynamic yield becomes significant.

The reactions on the rolls will depend, of course, on the method of loading; in the case of a two-roll reeler, or a three-roll machine, the material being straightened may be regarded as a simply supported beam carrying a concentrated load at the centre; the load on the deflecting roll will then be:

$$P = 4\frac{k Z \sigma_y}{L}$$

Where multi-roll machines are concerned, the material may be loaded on a number of spans and must be treated as a continuous beam. The worst loading conditions will be encountered when the moments are of sufficient magnitude to create near-plastic hinges at selected points, say at the intermediate supporting rolls and the deflecting rolls.

The bending moments at the supports being thus determined, the fixing moment diagram can be drawn and the free moment diagrams for each span superimposed. The difference between the free and the fixed moments at the centre of the deflecting rolls are the moments necessary to produce the required depth of plastic yield. The loads on the rolls may then be calculated in the usual way. The length of the loaded span must be a compromise between keeping the load and the deflection within reasonable limits.

### PASS SPEEDS

The factors affecting the choice of pass speed are: type of straightening machine, physical properties of the material, diameter, length, condition (i.e., amount of initial distortion to be rectified), the quality of surface finish of the product, and the type of entry and exit guides and mechanism provided.

The staggered roll type of straightener with rolls rotating in the plane of the pass line (Fig. 3), is used only to a limited extent for straightening rounds, usually black bars or tubes, at pass speeds ranging from 600 ft per min for $\frac{3}{8}$ in diameter to 100 ft per min for 6 in diameter. Lower speeds are, however, desirable from the points of view of safety and wear and tear of the machine if badly bent stock is to be processed, particularly if it is of heavy section.

Two-roll reelers, for reasons already mentioned, operate at lower throughput speeds than the inclined multi-roll types, but in either case the rotational speed of the bar or tube, even at moderate pass speeds, may be quite high and must be taken into account along with the whirling, which may be expected from the condition of the unstraightened material.

The rotational speed of the stock,

$$n_b = \frac{12\ V}{\pi\ D_b \tan\theta} = \frac{n_r D_r \cos\theta}{D_b}$$

where V = pass speed, ft per min
$D_b$ = diameter of stock, in
$\theta$ = angle of inclination of rolls to pass line
$n_r$ = speed of rolls, r.p.m.
$D_r$ = diameter of rolls, in.

From the above it will be seen that, other things being equal, the rotational speed of the stock varies directly as the pass speed and inversely as its diameter. The figures given in the tables below may be regarded as typical examples from practice of pass speeds and corresponding rotational speeds of rounds dealt with by reelers and high speed multi-roll straighteners.

Apart from excessive wear and accident risk, severe whipping of badly bent materials also interferes with smooth flow into the entry guides and straightening rolls, and may even stall the machine and generally interrupt the continuity of the process. These difficulties are most commonly encountered when hot rolled bars have to be dealt with, especially if they have been heat treated, in which case distortion may have taken place during quenching or through lack of care on the cooling bank.

Knuckle or cranked and flash ends on the bars may also be a source of trouble and are caused by blunt or badly adjusted shears or inadequate support during cutting off. Drawn bars and tubes are generally in a much better condition for straightening, the distortion to be rectified usually taking the form of a more or less uniform bow along the length. The importance of pre-straightening badly bent stock, either by hand or in a gag press, prior to high speed straightening, cannot be over-emphasised, as the benefits resulting from this treatment increase safety, reduce wear and breakdown, and ensure smoother production. It will be found, therefore, amply to compensate for the extra trouble involved.

Table III shows the pass speeds which it is reasonable to expect from reelers and high speed straighteners under average conditions when dealing with mild steel bars and tubes of medium wall thickness. In the case of reelers, the greater speeds are to be associated with higher angles of roll inclination. Alloy steel bars and tubes are best straightened at the lower speeds, owing to the greater deflection necessary to obtain the required depth of plastic yield. Light gauge tubes should be dealt with in multi-roll machines at moderate pass speeds and with bending centres of sufficient length to ensure the required deflection without imposing upon them roll pressures heavy enough to collapse the tube; preferably, all rolls should be driven and where very light tubes are concerned, this type of machine is essential.

The multi-roll machine, with all rolls driven, transmits a balanced torque to the material being straightened and on this account less roll pressure is required to drive the material through the machine; it is for this reason that machines of this type are capable of straightening at higher speeds, without inter-roll guides, and are especially suitable for dealing with very thin wall tubes. Very fast pass speeds, of up to 1,000 ft per min, are claimed by some makers, but such high speeds can only be realised over a limited range of diameters and when the stock is nearly straight before it is put through the machine.

TABLE II

| Type of machine | Pass speed, ft per min. | Range of bar or tube diameters: ¼ in–½ in Rotational speed, r.p.m. | Range of bar or tube diameters: 1 in–2 in Rotational speed, r.p.m. |
|---|---|---|---|
| Reelers (two roll) | 20 | 5,470–1,825 | 1,355– 685 |
| | 30 | 7,205–2,735 | 2,060–1,030 |
| | 60 | — –5,470 | 4,120–2,060 |
| | 80 | — –7,300 | — –2,740 |
| High speed straighteners (multi-roll) | 100 | 3,810–1,270 | 1,000– 500 |
| | 200 | 7,620–2,540 | 2,000–1,000 |
| | 300 | 10,440–3,480 | 3,000–1,500 |
| | 400 | — –4,650 | 4,000–2,000 |

TABLE III

*Reelers (two roll)*

| Bar diameter, in | Pass speed, ft per min | Tube diameter (O/D), in | Pass speed ft per min |
|---|---|---|---|
| $\frac{3}{8}$/$\frac{1}{2}$ | 30/40 | $\frac{3}{8}$/1 | 30/90 |
| 1/3 | 25/30 | 1¼/4½ | 25/75 |
| 3½/4½ | 20/25 | 4/8 | 20/60 |
| 5/6 | 15/20 | 8/12 | 15/45 |

*High speed straighteners (multi inclined rolls)*

| | | | |
|---|---|---|---|
| ½/1 | 150/300 | ½/3 | 150/300 |
| 1¼/3½ | 100/200 | 3½/6½ | 100/250 |
| 3½/6½ | 70/150 | 7/11 | 70/200 |
| 7/8 | 60/100 | 12/15 | 50/100 |
| | | 16/20 | 25/50 |

### PERFORMANCE

Research carried out in recent years has shown that many steels exhibit a notable increase in yield stress when subjected to very rapid loading. The increase in dynamic yield, as compared with static yield, is most marked in the case of medium carbon steels; in the case of low carbon steels it is somewhat lower and is almost negligible in heat treated low alloy steels. Multi inclined roll straighteners subject the material to alternating tensile and compressive stresses beyond the yield stress with very high rates of strain (yield stress being attained in from 1·0 to 10·0 milliseconds) even at moderate pass speeds, and it would seem that, apart from considerations of whip, this should be taken into account in determining the most satisfactory straightening speed for a given material.

The primary requirement in the performance of a straightening machine is, of course, that it should straighten the material put through it within the desired limits of accuracy; secondary requirements may include: rectification of the

TABLE IV

| Type of machine | Diameter of bar, in | Dimensions of tube, diameter × thickness, in | Material yield stress, tons/in² | Pass speed, ft per min. | Horse-power absorbed |
|---|---|---|---|---|---|
| Reeler (2-roll) .. . | 2 | — | M.S. | 24 | 18·7 |
| Reeler (2-roll) .. . | ⅜ | — | Alloy steel Y.S.44·7 | 20 | 3·5 |
| Abramsen (5-roll) .. | — | 10¾ × 0·279 | Low alloy Y.S.18·75 | 50 | 48·0 |
| Abramsen (5-roll) .. | 1½ | — | En.16, Y.S.30·0 | 73·5 | 18·75 |
| Abramsen (7-roll) .. | — | 2½ × 0·176 | M.S. | 100 | 12 |
| Abramsen (7-roll) . | — | 1½ × 0·05 | Stainless steel | 80 | 7·6 |
| Multi-roll (D-type) .. | — | 2½ × 0·188 | M.S. | 140 | 11·0 |

section, descaling, or the improvement of surface finish, all with a minimum power consumption. Straightness is a difficult quality to define and measure, but it is usually specified as the maximum deviation from perfect straightness in a given length. There is, however, no generally accepted standard either for the length or permissible error. On the Continent it is usually expressed as millimetres in one metre length, while in this country and the United States, it is given as inches in 10 ft, or some shorter length. If it is assumed that a deviation ($x$) over a length ($l$) is due to curvature in a circular arc, the error ($x_1$) over some other length ($l_1$) is very closely related to it, as follows: $\frac{x}{l^2} = \frac{x_1}{l_1^2}$.

In the case of mild steel, black bars and tubes, an error from 0·125 in to 0·150 in in 10 ft is regarded as commercially acceptable and can be achieved by the Abramsen type of straightener. Where greater precision is required, drawn bars and tubes can be straightened to an accuracy of 0·10 in to 0·05 in in 10 ft in two-roll reelers or multi-roll D type machines. A reduction of ovalisation of bars may be effected, but as heavy rolling pressure intensity is necessary, it must be done in a very rigid two-roll reeler with rolls designed to concentrate the rolling pressure over a limited length, and when high-tensile materials have to be dealt with the bars must be reeled hot, usually at a temperature of 700° to 800° C.

Ovality in tubes can be eliminated in a reeler with concave and convex rolls, or in a multi-roll straightener with concave rolls of hyperboloid contour, all, or most of the rolls being driven. Defects in surface finish, which sometimes originate in the straightening machine, may be caused by abrasion from guides, or spiral markings may result from concentrated olrl pressure. The latter may give rise to a definite sinking of the surface along the lines of roll contact, or to the appearance of stretcher strain markings (Lüder's lines) and ripple markings in the case of certain light alloys. Such markings may be avoided by lining inlet and outlet guides with non-abrasive material, the omission of inter-roll guides, and by using multi-straightening concave rolls accurately ground to correct contour and providing a long line of contact with the stock; each pair of opposing rolls should be driven.

For heavy descaling, a two-roll machine with suitable rolls, or a five-roll Abramsen machine will be effective.

The total power requirements of the straightener include the energy necessary to deform the material being straightened, rolling friction, internal losses in the machine (bearing and gearing friction), and friction losses in entry and exit guides.

When dealing with heavy bars or thick wall tubes, the deformation energy and rolling friction are the greatest components, but when the stock is thin wall tube or light bar, machine friction predominates. This is usually kept at a minimum by using anti-friction bearings and high efficiency gearing.

The results of tests of a number of different types of straightening machines, operating under various conditions, are summarised in table IV.

## CONCLUSION

From the foregoing, it will have been seen that many different kinds of straightener are available, and that the appropriate types are capable of performing efficiently all the finishing processes involved in the production of round stock. For the ordinary commercial straightening and descaling of bars and black tubes, the high speed five-roll Abramsen machine, or the seven-roll Abramsen for drawn tubes, will yield satisfactory results. Where greater precision, improved surface finish and correction of ovality in tubes are required, the two-roll reeler or multi-roll D type straightener will fulfil requirements. Ferrous and non-ferrous alloys, which have a yield stress close to the ultimate, should be straightened hot otherwise there is a risk of breakage in the machine.

# In Parliament

## A NEW SESSION BEGINS

Both Houses met at the end of October after the adjournment for the summer recess; the Lords on 21 October, mainly for the introduction of certain life peers, and the Commons on 23 October. On that date parliament was prorogued. The new session, being the fourth of the 41st Parliament of the United Kingdom of Great Britain and Northern Ireland, was then begun on 28 October and commenced with a state opening by H.M. The Queen on that date.

One of the earliest matters to be discussed in the Commons, after the date on the Address in reply to Her Majesty's speech from the throne, was in relation to exchanges of scientific, educational and cultural information. Mr. Hector Hughes (Labour) wanted to know what reciprocity in this connection existed between Great Britain, the United States and Russia, respectively, and what efforts had been made during the past six months to develop that reciprocity.

There had always been, he was told, a complete natural reciprocity in personal exchanges and the flow of scientific, educational and cultural publications between this country and the United States. Where appropriate, said Mr. Ian Harvey, the Joint Parliamentary Under-Secretary of State for Foreign Affairs, these exchanges received active encouragement from the Governments of both countries.

Desiring that the same situation should prevail between Great Britain and the Union of Soviet Socialist Republics, the British Government had proposed to the Soviet Government in April last that inter-governmental talks should be held on various aspects of freedom of information. The Soviet Government refused and the scope for exchanges between the two countries was thus limited. Within this limited sphere, however, reciprocal exchanges in the educational, cultural and scientific fields were arranged by the Soviet Relations Committee of the British Council, which was set up for that purpose in 1955 at the request of the British Government, and the scale of these arrangements had increased during the last six months.

Reciprocal exchanges of scientific publications had recently been intensified.

## SHIPBUILDING ORDERS DECLINE

Another subject which received early attention was the decline in the extent of orders for British ships. Mr. T. G. D. Galbraith, the Civil Lord of the Admiralty, informed Mr. F. T. Willey (labour) that no more than 90 new orders, totalling about 360,000 gross tons, had been placed with British shipbuilders so far this year, compared with 204 new orders, totalling approximately 1,665,000 gross tons, which had been placed during the first nine months of 1957. On the North East Coast area, approximately 150,000 gross tons of new orders had been placed this year. During the same period, licences totalling about 175,000 gross tons had been cancelled.

Mr. Galbraith said that although the decline in the orders received by British shipyards this year had been considerable, and in spite of some orders having been cancelled, in terms of launchings the shipbuilding industry had produced more gross tonnage this year than last. The industry still had an order book for nearly 5¾ million gross tons, but the situation, he told Mr. Hector Hughes (Labour), was becoming serious in those shipyards which had no appreciable amount of orders in hand.

The decline in new orders was accounted for by the current recession in world trade generally, depressed freight rates, and the consequential laying-up of merchant ships. It applied to a varying extent to all the major shipbuilding countries. An improvement in world trade must be looked to to bring about a recovery in ordering. In the meanwhile, every effort was being made to increase the competitive power of the British shipbuilding industry, including more modernisation and the re-equipment of the shipyards.

Actually, about 961,000 gross tons of new shipping had been launched by British shipyards so far this year, compared with 905,000 during the first nine months of 1957.

## NOISE FROM JET AIRCRAFT

Replying to questions from several members about noise tests to be passed by jet aircraft using London Airport, Mr. Harold Watkinson, the Minister of Transport and Civil Aviation, said that the agreed procedures for these aircraft required that they should achieve on taking off a height of not less than 1,000 ft over the nearest built-up area along the flight path and use reduced power; and that, on landing, they should maintain a glide path of not less than three degrees. These conditions were based on the results of tests carried out over many months under different auspices, first in Seattle, then in New York, and finally in London.

### Nuclear Submarines

Asked by Mr. Paul Williams (Independent Conservative) to make a statement regarding the progress being made with HMS Dreadnought, Mr. R. A. Allan, the Parliamentary and Financial Secretary to the Admiralty, said that a contract for the purchase of American nuclear submarine machinery was currently under negotiation. At the same time, good progress was being made with the limited amount of hull re-design which would be necessary to accommodate this machinery in HMS Dreadnought.

As to plans for the launching of a nuclear-powered merchant ship, Mr. T. G. D. Galbraith told Mr. Williams that the suitability of certain reactor systems for marine propulsion was still being evaluated.

### Recruiting Research Scientists

According to an answer by Mr. Iain Macleod, the Minister of Labour and National Service, the Civil Service Commission has reported that the recruitment of British scientists in the United States and Canada for research fellowships in this country has had encouraging results. He told Mr. Roy Mason (Labour), who raised the matter, that the United Kingdom Atomic Energy Authority had been associated with these efforts. This co-operation was very satisfactory and he hoped that other bodies who had employment to offer would follow the UKAEA's initiative.

### Colour Television

The British Broadcasting Corporation have completed a series of tests in colour television and have reported thereon to the Television Advisory Committee. Mr. Ernest Marples, the Postmaster-General, told Mr. A. Woodburn (Labour) that that committee had not yet reported to him, but he had asked them to do so as quickly as possible. He felt that it would be generally appreciated that there were many technical problems associated with the introduction of colour. It would be a pity to embark on expenditure on expensive colour equipment before these problems had been resolved.

### Giesl Front-End for Locomotives

Sir James Duncan, Bt. (National Liberal and Unionist) asked whether any research was being conducted on the Giesl front-end for locomotives and whether steps were being taken to obtain the loan for research purposes of two Giesl front-end units from the Austrian State Railways. In reply Mr. Harmar Nicholls, the Parliamentary Secretary to the Ministry of Works, said that he understood that this device was a combination of chimney and blow pipe.

The testing of existing devices of this kind was not considered to be a suitable subject for research within the establishments of the DSIR, since the suitability or adaptability of such a device for use on British Railways was one for them.

# THROUGH THE EYES OF A MANAGING DIRECTOR

*An Interview with*

## MR. IAN MORROW

*Until Lately Managing Director of the Brush Group*

*Interviewer:* Mr. Morrow, as we are here to discuss what the world looks like from the managing director's chair, and since you, in fact, have seen things from this viewpoint, I wonder whether you would first of all care to give us a brief personal history of how you came to sit in that chair.

*Mr. Ian Morrow:* When I left school I joined the jute industry. The effect was disastrous, and as they went on to a three-day week almost as soon as I joined, I gave that up and took up chartered accountancy, but as soon as I qualified I went back to industry—into silk manufacturing—so I had a fair spell in textiles. From there I went into consulting with an American firm, did a lot of work in the engineering industry, and then I founded with Mr. Robson our own firm of Robson, Morrow and Company, consulting chartered accountants. I spent nearly 10 years with them working in engineering, textiles, chemicals and other industries, including some work for nationalised industries, and then, in 1951, at the age of 39, I was invited to join the Brush Group, firstly as financial director and shortly afterwards I became deputy managing director, in the main responsible for the operation of the manufacturing units. Finally I was appointed managing director in 1957. And here I am today.

*Interviewer:* You have mentioned that your training was as an accountant. There has been some controversy as to why so many accountants are directors of engineering firms. I wonder if you would like to say a few words as to whether you feel that this is desirable. Do you consider that accountancy is a good training for a managing director, or is it, do you feel, just a matter of the personality concerned, the interests, and so on? Put in another way, do you believe that money is the measure of a company's activity and that its financial success is the standard by which the company should be judged?

*Mr. Ian Morrow:* Well, I don't think there is any ideal background for a managing director. In other words, I would not say that accounting training is either better or worse than an engineering training. What I think does matter is that when one becomes top brass, one is at least an expert in one of the skills which you have to control, because if you are an expert in one skill you realise how little the other experts know, whereas if you are not expert in any one thing then you are at the mercy of the others, which, of course, is not good for a managing director. As to the question of figures, I think nearly every senior manager in manufacturing industry finds, no matter what his background may be, that he has got to base a great deal of his judgment either on people or on figures and that technical considerations or technical knowledge is not pre-eminent, so that provided the engineer is able to interpret his figures and is able to evaluate people's judgment and their worth, he can very often do a better job than the accountant, but, as I said right at the beginning, I do not think background matters all that much. It is what the man is when he comes to the top job.

*Interviewer:* Since managing directors seem to be a somewhat obscure breed of men, might I ask you simply: what do managing directors do?

*Mr. Ian Morrow:* As presumably we are limited to a very few words, any picture I give you of what managing directors do must be imperfect. First, perhaps, the job is to appoint subordinates and select the subordinates in whom they have confidence to do whatever job is given to them. Another, perhaps, prime requirement for a managing director is that he will give decisions. There is, I think, nothing more corrupting in an organisation than a managing director who is either unwilling or unable to be decisive. Even if the decisions turn out to be wrong, at least the subordinates know what their instructions are and in what direction they are expected to move. It must be remembered that decisions can be split roughly into two groups—decisions that can be revoked and decisions that are irrevocable. What one might call the irrevocable decisions—particularly in this country—are those dealing with people, capital and development; these, once they are taken, ought to be followed through to the limit. The others, which can be revoked at short notice, are not so important and can be taken quickly and left to competent subordinates.

*Interviewer:* I wonder if I might interrupt there. I feel I have gone a bit ahead, and before asking you to define what a managing director does I should have asked what a company is, because I feel that some of your answers ought to be seen against that background. What do you believe the function of a company to be?

*Mr. Ian Morrow:* A company under, I think, any system, whether it be socialist, communist, or private enterprise, has two jobs to perform. First, it must justify itself economically. That is, it must be able to sell what it produces for rather more than what it costs.

Its second duty, and I think they must be in that order, is to create a reasonably happy community and create happy jobs and acceptable jobs for the people the company employs. This latter duty, I think, has been more prominent since the war than it was before the war and must never be underrated. To accomplish this, any company must be constantly endeavouring to make sure that its products are either acceptable now or will be when they have been developed, and that they can be produced at a price that the market is willing to pay. At the same time they must be able both to pay for and provide the amenities which will enable them to get the kind of employees they want, and by constant vigilance ensure that the company is one in which all can take a pride.

*Interviewer:* Before I interrupted you, Sir, you were talking about decision-taking. You spoke generally of decisions, but I wonder whether you could say something about the kind of decisions, giving a few examples, that a managing director, as distinct from his subordinates, would take.

*Mr. Ian Morrow:* In this instance, I can only speak from particular experience, but the obvious kind of decisions that a managing director would take are ones, of course, of promotion to senior posts from inside or getting people from outside. This I rank as a very important decision. Others are: How are the company's capital resources to be deployed? What is the development programme? Remember no company has enough people or money for everything. Then there are prices; is the company prepared to cut its prices, or is it going to increase its prices? In these days on the export market, how much credit is it prepared to give? As these can be massive decisions they nearly always have to go to the M.D. In the case of external relations, the M.D. would have to make decisions about whether he, personally, should interest himself in trade associations, government customers, and so on.

*Interviewer:* Who, Mr. Morrow, would be directly responsible to the managing director? And what decisions can they take independently?

*Mr. Ian Morrow:* Well, in a group such as the one with which I was connected the constituent companies had their own boards of which I was chairman, but the managing directors of these

companies had the power to buy their raw materials and sell their products. They had the power to hire and fire up to a fairly high level and, as I said earlier, it was only when you came to long-term irrevocable decisions that they had to come back to headquarters, that is, senior personnel, development and capital expenditure.

At headquarters there were staff directors, who were specialists in technical, financial, production and personnel problems, and they were always available to advise either the group managing director or the local managing director. In the subsidiary company, once the local board and the local managing director had decided, for example, on the development programme, the managing director would leave his chief engineer to get on with it and produce the product which met the specification that had been set down by the board. Similarly, he would leave to his sales director all the day-to-day contacts with customers, the organising of contracts, quotations, and so on, only intervening or, alternatively, helping when perhaps some very important customer came along or when some very extreme pressure was needed to obtain an order. Similarly, in the works he would delegate to his works manager the responsibility for running the works, dealing with the shop stewards, the unions, and organising the flow of work as long as he was able to produce the goods according to the programme.

In other words, any M.D. delegates as much as he possibly can but reserves the right to intervene when things are going wrong or look as though they might go wrong.

*Interviewer:* You have said, Mr. Morrow, that as much should be delegated as possible, but what are the channels? This may be indeed a meaningless question, but what are the channels through which a managing director can impress, if you like, his personality on the company. How can he mould the company? Does a managing director have his own concept of what the company should be in the future and work towards it and, if so, how does he cause this transformation?

*Mr. Ian Morrow:* Managing directors approach this from two angles. Either, like Viscount Montgomery the managing director sets out consciously to impose an image on his company or, alternatively, allows events to take their natural course. I suspect that most managing directors follow the latter procedure, and that merely by expressing their wishes and meeting people their personality and their particular thinking impregnates their company. These days a managing director would be expected to attend various social functions, to address meetings of apprentices, pensioners and so on—meeting executives at all levels and customers. By so doing, it is amazing how quickly his particular wishes, his particular way of looking at things, begins to mould the company, but, as you suggested, really to do it successfully he must have a clear-cut idea in his own mind as to what he wants to do and what he expects others to do, otherwise the picture or the mould will be one of confusion rather than one of enthusiasm and efficiency.

*Interviewer:* Perhaps I could ask for a little extension of this final point about the concept, because it seems to me that there are possibly two kinds of concept, one which is intrinsic or part of the background thinking of the managing director, but there is the possibility also that a managing director might have an idea of a definite place where he wants to take the company. He might, for instance, if they make, say, wire hausers, cherish an idea to convert the company to the production of perhaps more remunerative, electric cables. Or it might be a small company employing two or three hundred men, and he might have the vision of expanding to become a large multi-product company employing 3,000 men. Does this idea of a concept mean anything? Do, in fact, managing directors have this sort of concept at any time?

*Mr. Ian Morrow:* I think you have rather changed the question. In the first question you were asking about the managing director's personality or ideas being impressed on the company's day-to-day running. Your second question is on major policy as to where the company is going. This does not necessarily change the company's internal workings or even the internal image of the managing director.

Any company should have a long-term picture or policy of where it wants to go and what it is trying to do, either to stay where it is or to expand in its own industry, to match its competitors or to specialise, as the case may be. This picture may have to be changed rather frequently in some instances, less frequently in others, but this, of course, is more a base for discussion between the managing director and his board and a decision by the board on the managing director's proposals.

*Interviewer:* How about foresight?

*Mr. Ian Morrow:* Most managing directors' decisions are decisions which affect the future and to make them it is necessary to predict certain events on flimsy evidence. I think it was Lord Heyworth who said to one Government Commission that if he were right 51 per cent of the year in his decisions, he felt he had had a good year. Had he to face parliamentary questions as to why he was wrong on the other 49 per cent his job would have been insufferable and insupportable. The other side, of course, with managing directors is their ability to conduct external relations, again with customers or, in these days, with governments or with trade associations, as the case may be. They have to represent their company and, as such, must present to the world at large the picture of a successful, progressive and stable organisation.

*Interviewer:* Yes, Lord Heyworth's remark should certainly be taken to heart.

*Mr. Ian Morrow:* One difference between a managing directorship and other jobs is, as ex-President Truman said, the buck stops here. A managing director has no alibis for his decisions. He is, by and large, other than the board, the last court of appeal.

*Interviewer:* Ultimately, as you say, a company depends on the quality of its personnel, but there are occasions when it may be better to consult specialists outside. What do you believe to be the services that the company of average size should do for itself and what services it should contract out—such services as market research, product research, and that sort of thing. Do you believe that as much as possible should be contracted out to specialists, or do you feel that many of these problems can better be tackled by members of the company itself?

*Mr. Ian Morrow:* Well, any healthy, progressive company should have a fair idea of what the market is likely to want in five or ten years time and adjust its development programme accordingly, but there are times when a staff is overloaded and when it is vital that it collects some special report on either market probabilities or other people's development, and very often outside people can be invaluable in filling the gaps in the company's organisation or supplementing their own effort, but too much reliance on outsiders without some strength inside can be a source of weakness.

*Interviewer:* I have recently been reading an interesting American novel, *Cash McCall*, by Cameron Hawley; do you know it?

*Mr. Ian Morrow:* Yes, I've read it.

*Interviewer:* I remember that quite a lot of business associations are discussed in the book. In particular I wondered about consultant work. It seems to me that it is important to be able, if you are a consultant, or if you are employing a consultant, to recognise that the interests of consultant and client are not always coincident. Does the situation ever arise where there is a clash of interests?

*Mr. Ian Morrow:* The only likely clash of interests is that the client usually wants to get shot of the consultant as quickly as possible, and the consultant may wish to prolong his stay. But a serious answer to your question is that, provided proper terms of reference are drawn up at the beginning of the assignment, there should not be any clash, and provided the company knows how to use the information the consultant produces, they should derive benefit. The weakness, or the mistake sometimes made, is that when there is an unresolved problem, refuge is taken by passing it over to consultants, when, in fact, the board and the managing director should do their own job and take the decision.

*Interviewer:* How big do you think a group or company should be. Do you adopt the view that the bigger the better, and that you can always decentralise so as to offset the so-called disadvantage of over-large concerns, or do you feel that there is an optimum for a given kind of product, an optimum size of company, that is.

*Mr. Ian Morrow:* I think that the economic climate or the capital requirements of various sectors of industry make it inevitable that there should be large companies or large groups. A very obvious example is steel. Any increase in steel production means a massive capital investment which can only be found by a large group. I doubt if it is possible to say that there is an optimum for any industry. No doubt one method of measurement is to say that if a company is such that one man can control it and impress his personality on it then it is the optimum size. But again that must differ with different industries and with different products.

There never will be, in my view, any lack of opportunity for small companies because large groups, by their very nature, tend inevitably to bureaucracy and the thrusting small company can often do things that they could not even contemplate doing. It is doubtful if many in industry consciously decide on the size of their groups. It is much more that circumstances dictate the size of the groups; circumstances over which management has practically no control.

*Interviewer:* Continuing this discussion on group size and so on, and groups generally, what are your views on the character of a group? Do you feel that the relationship should be purely financial, that is, that capital can be transferred to the points at which it is required, rather like military resources, which can be quickly concentrated at points of weakness. Or do you feel that there should be some technical interlocking, that is, the engineering activities of the member companies should be co-ordinated in some way? Should it be simply financial interlocking or technical interlocking?

*Mr. Ian Morrow:* Many groups have started out with the ideal or the policy of having merely financial interlocking, but in almost every case this has broken down, due, I think to the fact that the managing director of the group sooner or later has to answer first to his board and then the board has to answer to the shareholders for the success or otherwise of the constituent members of the group. Once that is recognised, then the board of the parent company and the managing director of the parent company are responsible for the profitability or the losses of the constituent companies. Once this is recognised they must start to take an interest in the sales, the development and the production problems of the subsidiaries and have some part in the major decisions, which may be made under these heads. Therefore they become sooner or later an interlocked group where communications or decisions flow up and down and across in all the different fields. Finance, which started out to be the decisive influence, becomes a minor one.

*Interviewer:* Well, Sir, we have ranged far and wide over the managing director's domain; and I certainly feel much clearer myself as to his duties and responsibilities. Thank you for your most enlightening comments, Mr. Morrow.

## The Human Element

# *From One Level to Another*

An experiment in executive training will begin in London in the New Year, when the British Institute of Management, in collaboration with the Northampton College of Advanced Technology and Science, are holding a series of one-day seminars on "Communication." The first three are intended for senior managers who, will be asked to nominate a subordinate manager in their own organisation to undertake a similar training starting in the autumn of 1959 and, finally, yet another level of manager will complete the course. This is an interesting attempt to promote continuity in understanding the principles and techniques of communications within a company.

The latest publication of the European Productivity Agency (No. 30, September-October, 1958) contains sixteen articles on "Training and Adaptation for Modern Techniques." The central theme is the problem of understanding technical changes and of adapting them to the benefit of industry and society.

The articles attempt to give guidance on how man can keep abreast of such changes. Under the title "How Can Managers Keep Up-to-Date," Mr. Norman Fisher, principal of the Staff College of the National Coal Board, gives much practical guidance. Others, including Mr. G. Smellie, director of BISF's residential management training courses, and until recently works manager of the Steel Division of the Steel Company of Wales ("Training for Today and Preparing for Tomorrow"), provide useful summaries of their own knowledge and experience.

## *If Automation Comes*

The same issue of *European Productivity* (published recently in Paris by EPA) contains an article by Mr. B. Metz called "Adapting the Job to the Worker." It is a useful reminder that until the age of automation comes fully into existence there remains a good deal to be done to fit the job to the worker. He argues that the techniques of methods study and time and motion study are by no means anachronistic. Until the machine takes over more or less completely and we are all doing planning, progressing and supervising jobs of one sort or another a great deal remains to be done by way of design of equipment, layout and working conditions to raise the output of the worker and make him socially better integrated with his working environment.

There is a good deal less likelihood of the idea being overlooked in this country than in continental Europe. Across the Channel, if it becomes accepted that automation has brought about a revolution, the implications of that fact, both socially and technically, will be ruthlessly accepted at least among the intellectuals. In this country, sweeping intellectual formulae to explain changes are viewed with suspicion.

It is unlikely to be overlooked in Britain that automation is made for man not man for automation. The proposition is now widely accepted that automation is coming slowly with time for men and methods to take account of the change. Some who thought otherwise have already burnt their fingers.

## *Mobile Castle*

The White Paper issued last week on home ownership breaks a good deal of new ground. The Government propose to finance building societies, so that they can offer up to 95 per cent mortgages on houses and flats built before 1919 of a value up to £2,500. They will give a once-for-all insurance premium where purchase price exceeds valuation and they propose to arrange for the societies to include in the loan half the cost, to a limit of £400, of standard improvements and modernisation carried out under the existing improvements grant scheme.

The scheme will have the effect of raising the value of older property and of making home ownership more widespread. It will bring the acquisition of property to people who have never been able to acquire it before. Of all its many likely consequences the one worth brief consideration here is its effect on the mobility of labour. Will the ownership of a house make people less willing to move? It is to be remembered that those who are likely to use the facilities will be those with enterprise but small means—not vast in numbers but the cream of the labour market.

To judge from what is known already about mobility of labour, home ownership is not by itself a major factor in workers wanting to stay in a locality. After all, they have an asset to trade. But where areas have mainly rented property, often erected by local authorities, new homes to buy may be difficult to come by. Such areas have been the popular ones up to now but they may not be so for much longer.

## *Educational Suite*

Almost ten years ago, a pamphlet was issued by the Institution of Chemical Engineers called *Equipment of Chemical Engineering Laboratories*. Since then there have been a number of changes in both the size and number of courses available, and the Institution has decided to issue a further publication.

The latest is *Notes on Laboratories for the Teaching of Chemical Engineering*. This new pamphlet takes into account experience gained in the recent period of expansion and the suggestions of teachers who have seen the first publication. The equipment proposed is not considered to be exhaustive but is put forward as a reasonable guide for what is wanted for teaching.

It is recommended that since the object is to teach established theoretical principles and their practical application, the basis of equipment should be to provide a chemical laboratory, a physical laboratory, and a "plant" laboratory housing the engineering equipment. Storage space and some workshop facilities are also desirable as well as accommodation for demonstrators, for writing up laboratory notes and for storing drawings. In the view of the authors the whole unit should form a suite of laboratories having access to each other. The plant unit should be on the lowest floor level The services required are water, electricity, gas, compressed air, drainage, ventilation, heating for each laboratory and a steam supply at about 40 lb per sq. in.

## *Workless*

Unemployment at mid-October had risen to 514,000 or 2·3 per cent of the country's estimated labour force. There was an almost corresponding decrease in civil employment, of 29,000 to 23·1 million. The main changes in manufacturing industry were further falls in cotton, vehicles and metal manufacture, but rises in engineering, metal goods and precision instruments.

The detailed figures published by the Ministry of Labour give no indication of any change in the trend towards more unemployment, more short time and less overtime. At the end of September, 10 per cent more were on short-time than in August. Unfilled vacancies totalled 167,000 at 8 October, 12,000 less than in September. Relaxations in credit restrictions appear to have had little impact so far on the main downward trend in industrial activity—unless an otherwise steeper fall was prevented—and it remains to be seen whether the spectacular sweep away of hire-purchase restrictions will be more effective. Recent production statistics of the principal manufacturing industries suggest that they might.

Heavy declines in the output of motor and pedal cycles, television and radio sets, radiograms, and similar goods could be corrected almost overnight. The boom in car production will almost certainly be accentuated despite expected seasonal falls in exports. Sales of commercial vehicles, agricultural machinery, office appliances and a number of other items now available for hire purchase at unrestricted terms are likely to improve. The turning point will be the behaviour of industry's demand for machine tools.

## *Healthy Unemployment*

Over 3,000 company directors were given "some thoughts on full employment and stable prices" by Lord Cohen, chairman of the Council on Prices, Productivity and Income. He was speaking at a one-day conference of the Institute of Directors.

Lord Cohen's speech was strongly in defence of his Council's views on the degree of unemployment which was healthy for the industrial community. Pointing out that this month's figure was still well below Lord Beveridge's own definition of "full employment" (3 per cent unemployed or less), he said "we cannot hope to eliminate unemployment altogether unless we accept complete State control over industry and labour." The policy of getting unemployment down to the absolute minimum and keeping it there meant that demand should always be in excess of productive capacity. This, Lord Cohen emphasised, implies "continual shortages of goods and labour with large numbers of unfilled employment vacancies and irresistible tendencies to inflation of prices and wages." In so far as wages are concerned, it is important to distinguish between an increase in money terms and an increase in real terms. The latter cannot take place without a corresponding increase in productivity. Similar considerations apply to profits.

The difficulties of achieving a balance between increases in productivity on the one hand, distributed profits and wages on the other, were stated quite bluntly. Over the past ten years productivity had risen by an average of 2¼ per cent a year; a similar or even slightly higher average increase could doubtless be achieved, but much depends on the volume of sales, at home and abroad, and exports could hardly be increased satisfactorily unless costs were held down to levels affecting our main competitors.

## *Apprenticed to Commerce*

An attempt is being made to raise the standard of commercial education and training on a country-wide basis by the Association of British Chambers of Commerce. Their Commercial Apprenticeship Scheme, which was inaugurated in May, 1957, is making headway. So far, 102 companies have joined, 44 of them in Scotland. Some 200 apprentices have been or are in the process of being enrolled.

The ABCC point out in their review of progress that the field of education and training for commerce has been very neglected and express the hope that the initiative they have taken will lead to greater attention being paid to it by industry. The companies who have entered the scheme so far are providing a very high standard of training for their commercial recruits and are attracting very good quality entrants to the commercial side of industry. The need now is to obtain a larger measure of support from medium and small companies.

# Companies in the News

## Co-operative Costing

Two publications have been issued by the Association of Bronze and Brass Founders both called *Costing a Casting*. They have been compiled at the request of a number of the association's members which are not large enough to use specialised costing staff. The committee of the association, which undertook the work, decided that existing books on costing are written mainly for accountants, and that there was a need for something more simple which could be used by the foundry manager with the help of a clerk or typist. The system described in these two books is intended for foundries with a labour force up to 50, which will, in fact, cover the majority of the membership of this particular trade association.

Simple costing methods have been used to show how to estimate, how to put together actual costings for checking estimates, how to book labour costs and record other expenses, and how to improve future estimating. The object has been to avoid creating paper work by using and recording existing information in an orderly manner. The preparation of the books has been assisted by the use of conditional aid funds. The first book shows how a simple cost system is built up into a series of forms, and a procedure for using them. The second book deals with standard forms for costing, with actual figures worked out on some of them to illustrate what has been built up in the first book.

The association is to be congratulated on devising a system of this kind. It helps to prove, what many small concerns are unwilling to accept, that systematised clerical work using existing information can be organised to provide useful tools for estimating and costing. Beyond that lies the possibility that companies in a trade association which have adopted what is virtually a simple standard costing system may be willing to submit in confidence their cost figures to the association, and so enable the industry to benefit not only from a standardised cost system, but also from a published average cost, from which each concern can check its own performance.

## Uninterrupted Growth

The rapid progress of the leading civil engineering companies in recent years appears to be keeping up very well. Cementation Company have more than doubled their capital in the past five years—from £3·6 million to £8 million—and are able to earn continually rising profits. For the year ended 30 June trading profits passed the £ million mark to £1·03 million, compared with £933,000 the previous year. Mr. A. R. Neelands, their chairman, expressed his confidence in the future; the trend of business is encouraging and the volume of work on hand at the start of the current year was well up on 1957. The high risk element in the handling of large civil engineering contracts remains, however. In Mr. Neelands's own words, " a year is a short time in a business when so much depends on the timing of contracts."

Cementation are very active overseas where they have a number of operating subsidiaries and branch offices. India continues to be their main field of civil engineering activity; they have completed £4 million of work at Durgapur since starting in November, 1956, and are also making good headway with their contract for the Canada-India Atomic Reactor project near Bombay. In the Middle East, work is going ahead notwithstanding political storms and upheavals. In Iran, they have established a branch office, and are proceeding with their contract for a composite steel and concrete bridge across the river Karun. In Iraq, the Dokan Dam is approaching completion. Subsidiary companies operate in South Africa, Rhodesia, Canada and New Zealand within the Commonwealth, and in Spain, Portugal and Brazil. Associated companies in France (Les Travaux Souterrains) and Italy (S A Cementazioni per Opere Pubbliche) are also making progress.

Manufacturing interests have developed further and the company report satisfactory progress in the manufacture of aggregates from pulverised fuel ash, produced at Battersea under the name of Terlite. This material is said to be " fully up to expectations and acceptable to architects and engineers for a wide range of uses." Tanking work, antivibration and shock mountings, and acoustic materials are other products of the group.

## Promising Future

Acrow Engineers have had another record year and appear to be set for further advances. Their chairman, Mr. W. A. de Vigier, told shareholders in his annual report that the company's policy of diversification was beginning to bear fruit. The introduction of a full range of refrigeration units for the catering trade by Crawley Brothers, one of the group's subsidiaries, had been so successful that the whole of their production was sold 12 months ahead. Another subsidiary, Teles Smith, was almost equally successful with their range of lightweight saws for the forestry and timber trades. The Acrow-Demag division of the group are in full production and able to meet "the most exacting demands of almost every industrial undertaking which has a problem requiring cranes and hoists." The Hydraulics Division are well ahead with a range of hydraulic pit props which have been accepted by the National Coal Board.

These new developments place the Acrow Group in a strong position, particularly as the demand for their traditional products continues strong. The Acrow Formwork has been used in many constructional engineering schemes, including the Kariba Dam, the St. Lawrence Seaway, the Warsak Dam in Pakistan, the Roseland Dam in France and the Caroni Dam in Venezuela.

The group's profit was up substantially, to £636,500, and the board decided on increasing the ordinary dividend to 40 per cent for the year on increased capital, and in making a bonus issue of one "A" share for six ordinary or "A" ordinary shares held.

## Muscle or Motor

The future of the bicycle is clearly in the balance. For some time now the people of Western Europe have been substituting motors for muscle and making cycling a pleasure. For the first time " Le Sport " is being threatened and there has even been talk—sacrilegious as it undoubtedly is—of providing " Mopeds " for the supermen of the Tour de France. Now, like the " Scooter " a few years ago, the Moped has crossed the Channel and it is only a question of time before the word becomes as universal as bicycle, motor-cycle, or scooter.

Mopeds will be very much in evidence at the 32nd International Cycle and Motor Cycle Show starting at Earl's Court on 15 November. In their announcement headed " Mopeds for Everyone," the British Cycle and Motor Cycle Industries Association state that on the Continent, where some 7½ million are in use, " the moped is regarded as a bicycle." There is no driving test, no tax and no insurance (both required in this country as if it were in the same category as the fastest motor-cycle). It has, they say, " the best safety record of any motor vehicle." Already the mood is catching and some 300,000 are in use in the United Kingdom. It is cheap to run—four miles for one penny—and provides complete independence from public transport timetables. Raleigh Industries, Norman Cycles and Phillips are the principal exhibitors, together with Britax, who show a motorised wheel for conversion of pedal cycles, as well as a light, inexpensive moped. Altogether, 21 firms exhibit in the moped section, compared with 19 in the bicycle section, 25 in the motor cycle and 28 in the scooter.

The past few years have seen considerable advances in the field of two-wheeled transport, including radical changes in the design of motor-cycles and of bicycles. Each is fighting for a bigger share of the market, or for survival.

## Helicopter Success

The two principal manufacturers of helicopters, Fairey and Westland, are making good progress with the attractive ranges demonstrated at Farnborough in September. A military jet machine, the Fairey Ultra Light has been despatched to Canada for demonstration flights to the Navy, Army and Air Force. For the Navy it is required to take-off and land on a small platform on the after-end of a frigate, and for the Army as a casualty pick-up and air ambulance. Potential civil operators include the Royal Canadian Mounted Police, the Department of Transport, Spartan Air Services and Okanagan Helicopters of Vancouver. There are good prospects for this type of machine in Canada.

Westland Aircraft have had a very good year (up to 30 June), with trading profits £300,000 higher at £1·4 million. The main source of profit, however, has not been the helicopter business of the parent company but the air-conditioning equipment of their subsidiary Normalair. Much of their success has been due to their policy of offering to take full responsibility for the air conditioning of aircraft in the early design stage. Normalair units are in the Comet 4, and will be in the Vanguard as well as other British aircraft now in the design stage. Westland's other subsidiary, Westland Engineers, have also increased their profits through increased sales of their range of industrial doors.

The company now have four types of helicopters either in production or under development and should begin to reap the rewards of an enlightened and imaginative development policy.

## Americans in Scotland

Yet another American company have chosen Scotland as their European location. The Cincinnati Shaper Company, from Ohio, have formed a British subsidiary to manufacture press brakes and guillotine shears: the Cincinnati Shaper Company Limited, who have recently moved into the new town of East Kilbride, eight miles from Glasgow. The layout of the works, its equipment and the manufacturing techniques employed are in line with the most modern American heavy machine shop practice. Initially, production will be limited to ¼ in capacity guillotine shears and press brakes of 90 and 150 tons. Eventually, a full range will be made, up to 1½ in capacity guillotines and 1,400 ton press brakes.

The managing director is an American, David H. March, a vice-president of the parent company in Ohio. His explanation of the move is an interesting comment on the choice of Scotland as a location for United States industry: " we decided last year to establish a works abroad to expand our export markets and give better service to our overseas customers. The common language together with standards of measurement and the availability of heavy steel plate made Great Britain most suitable for our needs. We chose Scotland because the facilities available are excellent."

These reasons have been advanced before by other American firms now successfully settled in Scotland; they now number 45, including Caterpillar, Cummins, Euclid, IBM, Remington Rand and other leading companies. Scotland's attractions are doubtless the excellent facilities offered, but behind this lies the deep sentimental attachment to the old country. A leading industrialist recently described it as " an affair of the heart." Also, there is the excellent work done by the Scottish Council.

*Fourth in a Series of Consolidated Reports On t*

# RADIOACTIVE ISOTOPES

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IT is inevitable that the 1958 Atoms for Peace Conference had a different flavour from the first, held in 1955. The emphasis was then on all things new or at least newly emerged from some 15 years under-cover existence. This year on the other hand, only three years later, the story was rather one of the consolidation of established techniques and processes.

It is correspondingly more difficult to select the highlights for what cannot be an exhaustive review. This article has, therefore, been laid out on the basis of subjects, and the sections attempt to indicate the most interesting contributions to the study of their subjects from the various authors and countries concerned. Reference has been made, where appropriate, to papers prepared for the conference but not read at Geneva. It is unfortunately true that copies of some papers are still not generally available, a fact that may lead to regrettable omissions.

It is possible to see two distinct points of view for engineers in approaching isotope techniques. Most familiar is the use of such methods to aid existing processes, but the impact of large and very large sources on engineering and building design should not be forgotten. For example, a strong source needs a uniformly dense transport container which is often constructed of lead, cast into a mild-steel container. Production of such containers, however, cannot proceed without regular radiographic examination, with a large source, of the cast. It is, therefore, inevitable that the two aspects of industrial use of radioactive materials are interwoven.

## *Process Control and Measurement*

The largest number of papers presented, but not all read, describe various aspects of testing and monitoring technique. Several papers are themselves cast as surveys: references to them will subsequently be found under subjects and to some several times over.

### Thickness Gauges

Various forms of thickness gauge are discussed in papers from Belgium, USA, USSR, Canada, Rumania, Japan and UK. The majority are concerned with what must now be accepted as the conventional techniques. Paper P1349[1] from Japan presents an analysis of the errors involved in the use of randomly emitted particles or quanta and suggests preferred operating characteristics for thickness-gauge units using both gamma transmission and beta backscatter techniques. Paper P1347[2], also from Japan, describes the use of beta *bremsstrahlung* radiation for this purpose. The applications concerned in paper P1349[1] range from measurement of tin plating on steel, or of the asphalte in a tarpaulin paper "sandwich" structure, to checking the proper packing of gunpowder in fuses and of tobacco in cigarettes (perhaps more properly a "density" gauge).

The measurement of thin layers of plated metal is discussed in detail in paper P125[3] from Belgium in which a method utilising beta *bremsstrahlung* radiation is applied. Results limited only by statistical accuracy are claimed over a range of layer thickness from 2 to 200 mgm per sq. cm (40 $\mu$in to 4 thou). The best arrangement and mounting of the source is discussed for thallium 204 and phosphorus 32 active material.

Paper P1301[4] from Rumania describes in detail some laboratory investigations on the variation of lubricant film thickness with viscosity under given pressure conditions. While much of the discussion lies outside the range of isotope techniques—their help is invoked to accomplish the thickness measurement: this is done by a tracer technique—a Geiger counter measures, in effect, the specific activity of oil covering a standard area.

Two methods of introducing the tracer are described—in one phosphorus 32 is dissolved in the oil; in the other 0·1 per cent sulphur 32 is present as impurity and the oil is irradiated in a reactor before the experiment. It is shown that, for the short "cooking" time necessary to obtain the desired activity, there is no significant change in the lubricating properties of the oil base.

Brief mention is made in paper P216[5] from Canada of the use of beta gauges for process control in sheet steel, sheet paper, and sheet plastic production. Papers P1794[6] and P283[7] from the United States and United Kingdom, respectively, give comprehensive reviews of the use of isotopes in industry. The United States paper gives a thorough account of the currently used sources and their respective principal uses. The sources include beta, gamma and beta *bremsstrahlung* types—among the former the gas krypton 85 is shown to have substantial advantages, particularly in regard to safety, in thickness gauges. Paper P283[7] emphasises that developments in thickness-gauge technology have been mainly concerned with electronics; aiming at simplicity and reliability.

The most striking development has been the application, described in paper P285[8] from the United Kingdom, of fluorescent X-rays to thin-film gauging. These X-rays are also applied to other problems and are induced with considerable gain in usefulness by radioactive isotopes rather than by X-ray tubes. The use of alpha, beta, *bremsstrahlung*, and electron capture sources is described. The significance of the developments lies in the simplicity of the apparatus and the low intensity of source which allows adequate sensitivity. By the use of beta *bremsstrahlen* from a (nickel 63—antimony) source a thickness control gauge for photo-emulsions was produced which would not at the same time fog the film (paper P827[9] from the United States). This can be done by using X-rays of slightly higher energy than the absorption "edge" of the silver in the emulsion. The lower energy quanta are filtered out. Neutron activation of the silver plating inside a copper waveguide for thickness measurement is also described in this paper. A special beta counter for insertion in the guide was made, and irradiation is carried out by a 200 mC radium-beryllium source placed inside a moderating tank of water. The silver thickness (about 1 thou) can be determined to 10 $\mu$in in five minutes for 1 sq. cm of area.

### Density Gauges

An interesting survey of the uses of isotope energised density gauges is given in paper P283[7] from the United Kingdom. Short-term stability and sensitivity adequate to detect changes of 0·1 per cent in density of liquid flow in pipelines, for example, have been achieved. While less sensitive than the use of tracers in the flow the conveniences are obvious. Some industrial applications of gamma density gauges in Japan are described in paper P1349[1] and similar uses are also mentioned in the Canadian paper (P216).[5]

## GENEVA DISTILLATE

Prolific in papers and enormous in scope, the Second International Conference on the Peaceful Uses of Atomic Energy can only assume its true significance when the information presented there has been thoroughly digested. As a stage in this process, ENGINEERING has commissioned fourteen specialists to summarise the matter of the Conference under a number of subject headings. The process may be regarded as one of distillation, with concentrated fractions drawn off at various levels. The contributors have consolidated the information published during the Conference, selecting the essentials, reconciling the submissions of different authors and countries, and tabulating the most important data. As an introduction to the series, we published on 19 September Sir John Cockcroft's overall survey of the Conference. The present series is being published roughly at weekly intervals and will include thirteen articles in accordance with the accompanying table. The Conference was held in Geneva and lasted from 1 to 13 September.

| | | |
|---|---|---|
| Power Reactors | | Mr. G. W. K. Ford, Research Manager, Dounreay |
| Research Reactors | | Dr. V. S. Crocker, Reactor Division, Harwell |
| Thermonuclear Research: | | |
| (Pinch Effect) | | Dr. A. A. Ware, AEI Research Laboratory |
| (Other Devices) | | Dr. R. J. Bickerton, Controlled Thermonuclear Research Division, Harwell |
| Propulsion | (7 November, page 600) | Mr. B. T. Price, Reactor Division, Harwell |
| Radiation Shielding | (31 October, page 568) | Mr. J. D. Jones, Reactor Division, Harwell |
| Engineering | | Mr. R. P. Kinsey, Chief Engineer, Advanced Reactor Design Office, Risley |
| Metallurgy | | Mr. L. M. Wyatt, Technical Manager, Central Technical Services, Research and Development Division, Risley |
| Instrumentation | | Mr. R. B. Stephens, Mullard Equipment Ltd. |
| Nuclear Physics | (24 October, page 536) | Dr. M. J. Poole, Nuclear Physics Division, Harwell<br>Dr. M. Sowerby, Nuclear Physics Division, Harwell |
| Radioactive Isotopes | | Mr. E. R. Wiblin, Isotope Division, Harwell |
| Isotope Separation | | Dr. H. Kronberger, Director, Research and Development, Risley |
| Chemistry and Processing | | Dr. R. Hurst, Director, Dounreay |

# On the 1958 Geneva Atomic Energy Conference

### Measurement of Humidity in Soils

The measurement of humidity in soils is referred to in papers P283[7] (United Kingdom), P1794[6] (United States) and P1231[10] (France). They are based on the moderating and absorbing effect of hydrogen on fast neutrons from a radium-beryllium or polonium-beryllium source.

### Level Gauges

Several papers describe the use of level gauges—usually referring to liquid process—although the Canadian paper (P216)[5] refers to gamma level gauges used in connection with iron-ore and graphite operations. A survey paper (P1794)[6] from the United States, points out the utility of lower energy beta excited X-rays for such purposes when the substance to be checked is of low density. Automatic homing and control is less concerned with the isotope head than with electro-mechanical servo-systems —paper P283[7] (United Kingdom).

## *Measurement of Wear*

Much public attention has been focused by advertisements on the problems of internal combustion engine wear and of lubrication. A number of references including a "read" paper, were made to this particular use of isotopes. For some time radioactive piston rings have been used to indicate wear by "counting" the lubricating oil in static engine experiments. Such laboratory studies are referred to in papers P216[5] from Canada and P1431[11] from the United States. The activity used is that of iron 59 obtained by irradiating the rings in a reactor. In the Canadian experiments corrections for decay were avoided by dissolving a small quantity of active "ring" for use as a standard. Striking reductions in wear for some additives can be observed.

In order to carry out tests under more strictly operational conditions, a British team fitted a car as a mobile laboratory (paper P94[12]). Sump oil is circulated around a scintillation counter whose output is fed to a recording system. The need for suppressing corrosive wear during "warm-up" is clearly demonstrated in the preliminary records of this work. Elimination of the phenomenon is claimed for some inhibiting additives. The car and equipment were on view at the Commercial Exhibition in Geneva.

Different aspects of wear study are described in papers P803[13] and P819[14] from the United States. The former refers to more basic studies of friction and wear between sliding surfaces using autoradiography of one member (previously inactive) after friction with the other (previously activated). This technique may be varied by activation of the transferred material after friction. Particular reference is made to rapid determination of rates of wear in cutting tools, case hardened steel surfaces and ball bearings. In paper P819[14] emphasis is laid on the post-wear activation technique as applied to gear wear in various lubricants. Samples of the latter were irradiated and counted against a standard (as in the Canadian piston-ring technique). It is obvious that some element, unique to the wearing member, must provide the activity —in this case manganese 56, derived from manganese 55, could only come from the gears.

## *Radiography*

Non-destructive testing of, for example, metal castings, by X-ray examination is well established. Radioactive isotopes play an increasing part in this practice and most of the work reported concerns refinement or variations in technique. Thulium 170, cerium 144, iridium 192, caesium 137, cobalt 60 are established gamma sources for this work. Their energies, in the order given, are suitable for increasing thickness of material. To them may be added xenon 133 which has the advantage (from the point of view of definition) of being an easily adsorbed gas; a very small and intense source may thus be made. This isotope, together with gadolinium 153, samarium 145, americium 241, europium 155, gives further low-energy gamma sources; all the latter have the advantage of longer half life than xenon 135 or thulium 170. A full summary of their properties is given in paper P1794[6] from United States while the use of thulium 170, europium 155 and cerium 144 for testing thin-walled products is specifically discussed in paper P2235[15] from USSR. The properties of europium 155 and its advantage of high specific activity are discussed in regard to portable units in paper P822[16] from United States. By virtue of the gamma energies it is closely comparable to a standard 50 kV X-ray set and has little *bremsstrahlen* contamination since the beta energies are low. It is, however, expensive since it needs a separated parent (samarium 154).

A conventional isotope (cobalt 60) used in a less conventional manner for comparing samples with a standard for quality control is described in paper P1347[2] from Japan. This paper also describes conventional radiographic uses of thulium 170 and cobalt 60 for, respectively, "thin" and "thick" samples.

The search for more low-energy gamma-ray emitters comparable to machines for X-radiography has led to considerable use of beta-excited *bremsstrahlung* sources. The advantages of promethium 147 (used as tungstate-forming a source-target mixture) are pointed out in paper P828[17] from the United States. Some interesting comparative radiographs are shown.

Paper P283[7] from the United Kingdom describes the specialised radiography, of for example, a sheet of paper by means of alpha particles from polonium 210. The well defined range of such particles enables variations in thickness to be plotted as contours on a photographic film separated from the source by the paper. A 35 mm camera unit is described for performing routine operations of this kind.

At the other end of the scale the higher gamma energy of sodium has been used for testing thick dense samples. Although no specific examples are quoted in the papers, the film shown by the United Kingdom at the Commercial Exhibition reminded us of the examination of one of the great Trilithons at Stonehenge.

### Autoradiography

Considerable use is made of active materials in the analysis of metallurgical problems. For example, paper P2236[18] from USSR described investigations of the redistribution of elements in alloys and in welds. Autoradiographs of active materials can reveal their positions irrespective of whether they remain isolated in an alloy or are really in solid solution. In welding processes introduction of active isotopes into, for example the base metal, the electrode wire or the covering (flux) in turn, can demonstrate movements of sulphur, or carbon according to the isotope introduced.

Paper P2240[19] from Hungary describes an investigation to determine the liquid core length in steel ingots produced by the continuous casting process. Both autoradiographs from active phosphorus 32 mixed in the molten metal, and tungsten "sinkers" containing cobalt 60 sources were used. While there was some doubt as to the value of the phosphorus 32 autoradiograph there seemed little question of the accuracy and value of the cobalt 60 instrumental method.

Paper P819[14] from the United States describes neutron, deuteron and photo irradiation to produce activation autoradiographs of inclusions and grain boundary segregations in metals. By a selection of irradiation type and energy the element shown up in the radiograph can be chosen by reference to a calibration of film density and time of exposure. An "intensifying" method for autoradiography of, for example, activity-bearing rocks, is described in paper P1762[20] from the United States. A zinc sulphide screen is interposed and is activated by the alphas from the active material. This allows normal optically sensitive films to be used with improvement in speed.

## *Measurement of Flow*

Several applications of isotope techniques to the measurement of flow and movement are given. Tracer technique is used in those described in paper P216[5] (Canada) and P283[7] (United Kingdom) and the total-count-technique of paper P817[21] (United States) for pipeline and river flow problems gives a valuable simplification of interpretation. All papers emphasise the utility of using a short lived isotope such as gold 198 or sodium 24. Paper P283[7] (United Kingdom) also described the convenience of krypton 85 as a gaseous tracer for gas flow and leak detection problems.

Neutron activation for *in situ* flow measurement is described in paper P819[14] (United States). The method does not necessarily involve interference with the liquids flowing: even when it does, the added material is initially inactive. A very short-lived activity can be used in, for example, the case of water by making use of the nitrogen 16 derived from neutron irradiation of the oxygen in water. It is not explained how a deuteron accelerator is carried around to make the 14·7 MeV neutrons!

## *Civil Engineering*

Studies of sand and silt movement in rivers or on sea shores have been made in many places. A sensitive method of measuring the sand movements near a Portuguese port is described in paper P1820.[22] Silver 110 is deposited on the sand grains and can later be extracted. The sensitivity of the method is very high. A paper (P1613)[23] from Israel describes the use of tracer technique in the study of water in geological aquifers and soils. Depending on the soil constitution cobalt 60 was chosen in the Lydda region. Labelling with tracers has been used in the study of cement technology in France (paper P1231)[10] and Sweden (P166)[24] and more academically of plaster of paris solidification in Canada (paper P216).[5] The latter paper also describes the use of wood fibres, tagged by ion exchange processes, to study flow in paper-making machines. Various logging techniques for boreholes have been reported previously and a short account of petrol and gas deposit investigation, by the study of natural rock activity is given in paper P1303[25] from Rumania.

## *Analysis and Tracer Methods*

Review papers from Sweden (P166)[24], United States (P803,[13] P827,[9] P834,[26]) and United Kingdom (P283)[7] include descriptions of techniques in metallurgy, the cellulose industry, the steel industry, sugar refining and in microgram-scale analysis.

## *Effects of Radiation*

Paper P803[13] from USA includes descriptions of the effects of radiation on metals, on their mechanical properties, electrical and thermal conductivity and on surface reactions and corrosion. Creep and corrosion are, for example, of vital interest to reactor designers. Effects in non-metals are discussed in paper P802[27] (USA).

The effects on lubricants and polymers in nuclear power plants are discussed in paper P2384[28] from the USA. Dose resistance can, for example, be increased by factors of up to 100 by suitable additives to oils.

Many papers describe the effects of radiation on polymers—including P1346[29] from Japan and P2085[30] from USSR. The latter describes the use of a 21,000 curie cobalt 60 irradiation unit.

An equally large number of papers discuss biological effects—such as food sterilisation—in which the engineering design of plant plays and will play increasingly in the future, a vital part. Two examples may be quoted—irradition of potatoes to improve storage characteristics by inhibiting sprouting has been studied in many countries. China (P131),[31] Russia (P2131)[32] and Norway (P568).[33] The Russian paper scores a "first" in that irradiated potatoes are now permitted for human consumption in USSR. Rumania (paper P1298)[31] describes the stimulation not of potatoes but of grapevine seeds!

The purification of "whole egg" is discussed in paper P64[35] from UK. Since infective bacilli can be killed while the imported material is still frozen the method has obvious advantages. While these examples—together with that of paper P276[36] (also UK), discussing pharmaceutical sterilisation—are not strictly engineering applications, the order of magnitude of dose required for sterilisation (approximately $10^6$ rads) indicates the size of source needed. This, in turn, reflects on the larger plants and in particular, buildings, necessary to produce, handle and contain sources of up to 1 million C.

Such sources (of cobalt 60 or caesium 137 in general) are to be expected during the next 10 years. Papers P288[37] (UK) and P1235[38] (France) give some idea of the problems of cobalt 60 production—while paper P831[39] (USA) and P1179[40] (France) discuss—together with some others in the USA paper—the production of caesium 137 sources from the fission products of large reactor programmes.

Several papers discuss handling problems and their engineering aspects—perhaps the most comprehensive review is given in paper P1459[41] from the UK. This discusses many points not necessarily applicable to cobalt 60 or caesium 137 usage—but the problems of screening, viewing and handling large sources are similar. Some details of a USSR radiochemical laboratory are given in paper P2026.[42] A small prototype installation utilising gamma rays from the decaying fission products in used fuel elements is described in the paper P1212[43] from France.

Some of the engineering problems in using kilocurie sources for teletherapy are given in papers P2403[44] from USA, P67[45] from UK and P2056[46] from USSR, while paper P90[47] from UK describes some typical units and compares them with irradition machines for research.

## *Economic Aspects*

The overall picture is hard to assess—in UK and USA the costing of isotope production and utilisation is a developing art, as yet incomplete. Money talks, however, in the evaluation of the utility in industry of isotope techniques. The three largest producer and user countries, UK, USA, USSR, have estimated savings attributable to the uses of isotopes of millions of pounds and roubles, and hundreds of millions of dollars.

If the Very Large Source programme, just round the corner now, lives up to its expectations, it may, by the time another large-scale conference descends upon us, be possible to be more precise in this scale of values.


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# Atomic Review

## *Notes and News*

### Power Reactor for Japan Hovers

The £20 million 150 MW nuclear power station for which tenders have been invited from three British power groups (these including GEC, AEI and English Electric) is still under consideration. The prospective purchaser, the Japan Atomic Power Generating Company, hopes to send out letters of intent next month. After completing their technical examination this month the Japanese company propose to open the price lists of the three competing groups. A spokesman said that failing a loan from the World Bank to cover part of the cost, the company would ask the British contractor to provide credits to finance the import of the reactor.

### Boiling Water Reactor for Britain

It has been reported that the UKAEA is to build an experimental boiling-water reactor at Windscale or Dounreay. The success of the USAEC's Argonne National Laboratory's Experimental Boiling Water Reactor (EBWR) has no doubt contributed towards this decision. The American General Electric Company has also demonstrated the feasibility of a boiling-water reactor for ship propulsion.

### South Pole Power

A nuclear power plant is to be built by the United States at McMurdo Sound in the Antarctic.

### Advanced Gas Cooled Reactor Contracts

The UKAEA have announced that contracts have been placed for the Advanced Gas Cooled Reactor to be built at Windscale, and are as follows: reactor vessel (Whessoe), turbo-alternators and associated plant (English Electric), heat exchangers (International Combustion), containment building (Babcock and Wilcox), dump condenser (Hick, Hargreaves), feed pumps (Mather and Platt), building and civil engineering (Whatlings). Consultants for turbo-alternators and steam plant within the turbine hall generally are Ewbank and Partners.

### American Nuclear Society Meeting

The 1958 meeting of the American Nuclear Society will be held in Detroit, from 8 to 10 December. Among the proceedings will be a complete report on the Second International Conference on the Peaceful Uses of Atomic Energy, held in Geneva. Chairman will be Dr. L. R. Hafstad, research vice-president of General Motors and Mr. Walker L. Cisler, president of Detroit Edison. The executive secretary is Mr. Octave J. Du Temple, American Nuclear Society, Chicago 1, Illinois, USA.

### 1959 Nuclear Congress

Some 30 United States engineering, scientific and management groups have combined to sponsor the 1959 Nuclear Congress, which will be held at the Public Auditorium, Cleveland, Ohio, U.S.A., from 5 to 9 April, next year. The general theme will be "For Mankind's Progress" and the congress will comprise the seventh Hot Laboratories and Equipment Conference, the fifth Nuclear Engineering and Science Conference, the seventh Atomic Energy Management Conference, and the Atomfair, designed to appeal to engineers, scientists, industrial executives, research workers, and manufacturers and users of nuclear devices. The co-ordinating body, from whom further information may be obtained, is the Engineers' Joint Council, 29 West 39th Street, New York 18, U.S.A.

### Atomic Industrial Forum Conference

The 1958 annual conference of the American Atomic Industrial Forum was held on 10 to 12 November and subjects included nuclear liability protection, United States power reactor projects and experience, patents, radiation applications, law, the Euratom programme and summaries of Geneva conference papers.

# NOTICES OF MEETINGS

### Association of Supervising Electrical Engineers and Institution of Engineers-in-Charge

LONDON
"Some Aspects of Railway Electrification," by R. Ledger. Annual Joint Meeting. Magnet House, Kingsway, W.C.2. Tues., 18 Nov., 6.30 p.m.

### British Institution of Radio Engineers

EDINBURGH
"An Electronic Engine Indicator," by G. F. Norman; and "An Electronic Pin Hole Detector for Tin Plate Inspection," by D. Goodwin. Scottish Section. Department of Natural Philosophy, The University, Drummond Street, Edinburgh. Fri., 21 Nov., 7 p.m.
GLASGOW
"An Electronic Engine Indicator," by G. F. Norman; and "An Electronic Pin Hole Detector for Tin Plate Inspection," by D. Goodwin. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. Thurs., 20 Nov., 7 p.m.

### Chemical Society

BRISTOL
"Plastics in Packaging," by F. A. Paine. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., 20 Nov., 6.30 p.m.
HULL
"Alkyls and Aryls of Transition Metals," by Dr. J. Chatt. Hull Branch. Organic Lecture Theatre, The University, Hull. Tues., 20 Nov., 7.30 p.m.
NEWCASTLE UPON TYNE
"Recent Developments in Quantum Chemistry," by Professor H. C. Longuet-Higgins. Newcastle upon Tyne Branch. Chemistry Department, The University, Newcastle upon Tyne. Fri., 21 Nov., 5.30 p.m.

### Combustion Engineering Association

CARDIFF
"Smoke Abatement," by J. Lawrence, at 10.30 a.m.; and "Grit and Dust Collecting Equipment for the Smaller Plant," by G. Oddy. Park Hotel, Cardiff. Wed., 19 Nov.

### Diesel Engineers and Users Association

LONDON
"Notes on the Jerk System of Fuel Injection," by W. A. Green and G. R. Green. Institute of Marine Engineers, 76 Mark Lane, E.C.3. Thurs., 20 Nov., 2.30 p.m.

### Faraday Society

GLASGOW
"The Relation Between Ion Mobility and Viscosity in Aqueous Solutions," by Professor R. H. Stokes (University of New England, NSW, Australia). Chemistry Department, The University, Glasgow. Tues., 18 Nov., 4 p.m.

### Illuminating Engineering Society

BRISTOL
"The Stage and the Lighting Engineer," by F. P. Bentham. Bath and Bristol Centre. Offices of the South Western Electricity Board, Bristol. Mon., 17 Nov., 7 p.m.
LIVERPOOL
"Recent Industrial Installations and Some Particular Problems," by J. G. Holmes. Liverpool Centre. Industrial Development Centre, Merseyside and North Wales Electricity Board, Liverpool. Tues., 18 Nov., 6 p.m.

### Incorporated Plant Engineers

BLACKBURN
"Application of Plant and Instrumentation to the Testing of Gas Turbine Combustion Chambers," by Dr. A. E. Clarke. Blackburn Branch. White Bull Hotel, Blackburn. Thurs., 20 Nov., 7.30 p.m.
DARTFORD
"Cathodic Protection," by L. B. Hogben. Kent Branch. Railway Hotel, Dartford. Wed., 19 Nov., 7 p.m.

### Incorporated Sales Managers' Association

LONDON
"Six Keys to Sales Control," by John Houghton. London Branch. Royal Society of Arts, John Adam Street, Adelphi, W.C.2. Mon., 17 Nov., 6.30 p.m.*

### Institute of Marine Engineers

FALMOUTH
"Oil Fuel Burning," by R. B. Cooper. Junior Lecture. Technical College, Falmouth. Thurs., 20 Nov., 7.15 p.m.
KINGSTON-UPON-HULL
"The Controllable Pitch Propeller," by H. Twitchen. Kingston-upon-Hull and East Midlands Section. Royal Station Hotel, Kingston-upon-Hull. Thurs., 20 Nov., 7.30 p.m.

### Institute of Metals

SHEFFIELD
"Chromium and Its Alloys," by E. A. Brandes. Sheffield Local Section. The University, St. George's Square, Sheffield. Thurs., 20 Nov., 7.30 p.m.

### Institute of Petroleum

LONDON
"Films in the Oil Industry," by R. F. Leach. London Branch. Thurs., 20 Nov., 6 p.m.*

### Institute of Road Transport Engineers

LONDON
"Taking Stock on Maintenance," by P. H. Wyke Smith. Metropolitan Area. Royal Society of Arts, John Adam Street, Adelphi, W.C.2. Thurs., 20 Nov., 6.30 p.m.*
EDINBURGH
"The Free-Piston Gasifier, with Special Reference to Vehicle Application," by Dr. F. J. Wallace. Scottish Centre. North British Hotel, Princes Street, Edinburgh. Mon., 17 Nov., 7.30 p.m.
LEEDS
"Design of Radial-Flow Turbo-Chargers and Their Application to Road Transport and Public Service Vehicles," by E. Kellett. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 20 Nov., 7.30 p.m.

### Institution of British Agricultural Engineers

NEWCASTLE UPON TYNE
"Soil Stabilisation Roads for Agricultural Use," by F. W. Ingles. Northern Centre. North Eastern Electricity Board's offices, Newcastle upon Tyne. Mon., 17 Nov., 6.45 p.m.

### Institution of Chemical Engineers

BIRMINGHAM
"Chemical Engineering Aspects of Tar Acid Recovery," by D. McNeil. Midlands Branch. Birmingham College of Technology, Gosta Green, Birmingham. Wed., 19 Nov., 6.30 p.m.

### Institution of Civil Engineers

LONDON
"Soil Engineering at Steep Rock Iron Mine, Ontario, Canada," by R. F. Legget. Tues., 18 Nov., 5.30 p.m.*
BIRMINGHAM
"Operational Experience at Calder Hall," by K. L. Stretch. Midlands Association. Joint meeting with local sections of the Institutions of Mechanical and Electrical Engineers. Midland Institute, Paradise Street, Birmingham 1. Fri., 21 Nov., 6.30 p.m.
LIVERPOOL
Address by the chairman of the Association, J. P. Bamber. North Western Association. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Wed., 19 Nov., 6.30 p.m.

### Institution of Electrical Engineers

LONDON
Discussion on "Ferro-Electrics," opened by L. A. Thomas. Measurement and Control Section. Tues., 18 Nov., 5.30 p.m.*
"Television Recording: A Survey of the Problems and Methods Currently in Use," by J. Redmond. Radio and Telecommunication Section. Wed., 19 Nov., 5.30 p.m.*
Discussion on "What is a Cultured Engineer?" opened by Dr. K. R. Sturley. Education Discussion Circle. Thurs., 20 Nov., 6 p.m.*
Address by the President, S. E. Goodall. London Graduate and Student Section. Mon., 17 Nov., 6.30 p.m.*
CARLISLE
"Some Aspects of Heat-Pump Operation in Great Britain, with Particular Reference to the Sheffield Installation," by Miriam V. Griffith. North Eastern Centre. Carlisle Technical College, Carlisle. Fri., 21 Nov., 7 p.m.
SALISBURY
"Colour Television," by C. J. Stubbington. Southern Centre. Offices of the Southern Electricity Board, 17 New Canal, Salisbury. Wed., 19 Nov., 6.30 p.m.*

### Institution of Electronics

LONDON
"Applications of Transistors in Communications and Control Equipment," by E. Wolfendale. London Division. Institute of Education, University of London, Malet Street, W.C.1. Thurs., 20 Nov., 7 p.m.

### Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Modern Pumping Arrangements for Oil Tankers," by Commander E. H. W. Platt, R.N. (ret.). Tues., 18 Nov., 6.30 p.m.

### Institution of Heating and Ventilating Engineers

MANCHESTER
"Air Conditioning in Hospitals," by J. P. Sandison. Manchester Branch. Engineers' Club, Albert Square, Mancheste Fri., 21 Nov., 6.30 p.m.
SHEFFIELD
"The Clean Air Act," by J. W. Batey. Yorkshire Branch. Grand Hotel, Sheffield. Wed., 19 Nov., 7.30 p.m.

### Institution of Highway Engineers

LEEDS
"Highway Law," by E. Gilbert Sharp. Yorkshire and Lincolnshire Branch. The University, Leeds. Thurs., 20 Nov., 7 p.m.

### Institution of Mechanical Engineers

LONDON
Thomas Hawkesley Lecture: "The Transmission of Acoustic Waves Through Structures," by Professor L. L. Beranek. Fri., 21 Nov., 6 p.m.*
Discussion on "Working Stresses and Factors of Ignorance." Applied Mechanics Group. Wed., 19 Nov., 6 p.m.*
BELFAST
"Recent Developments in Journal Bearing Design with Mention of Dry Bearings," by R. J. Welsh. Northern Ireland Branch. Kensington Hotel, Belfast. Thurs., 20 Nov., 7.30 p.m.
CAMBRIDGE
"The ZETA Reactor," by A. R. Carruthers. Eastern Branch. Cambridge Technical College, Collier Road, Cambridge. Mon., 17 Nov., 6.30 p.m.
NEWCASTLE UPON TYNE
"Bases of Measurement," by H. Barrell. North Eastern Branch. King's College, Newcastle upon Tyne. Mon., 17 Nov., 6.30 p.m.

### Institution of Mining and Metallurgy

LONDON
"Oxidation Rates of Lump Copper-Iron Sulphides and "Oxidation of Powder Compacts of Copper-Iron Sulphides," by Dr. T. A. Henderson; and "Further Factors Affecting Percussive Drilling Performance," by Dr. I. W. Inett. Geological Society, Burlington House, Piccadilly, W.1. Thurs., 20 Nov., 5 p.m.*

### Institution of Production Engineers

LONDON
"Human and Organisational Problems in Inspection Departments," by R. M. McKenzie. London Section. Royal Empire Society, Northumberland Avenue, W.C.2. Thurs., 20 Nov., 7 p.m.
BIRMINGHAM
"Cold Extrusion of Metals," by R. Tilsley. Birmingham Section. James Watt Memorial Institute, Great Charles Street, Birmingham. Wed., 19 Nov., 7.30 p.m.
OXFORD
"Motor Cars," by J. F. Bramley. Oxford Section. Town Hall, Oxford. Tues., 18 Nov., 7.30 p.m.

### Institution of Structual Engineers

BRISTOL
"Strength of Lattice Girders," by M. Holmes. Western Counties Branch. University Engineering Laboratories, Bristol. Thurs., 20 Nov., 6 p.m.
LIVERPOOL
"Housing the Dounreay Fast Reactor," by N. T. Barrett. Lancashire and Cheshire Branch. College of Building, Liverpool. Wed., 19 Nov., 6.30 p.m.

### Junior Institution of Engineers

LONDON
"Printed Circuit Techniques," by P. A. Trigg. Fri., 21 Nov., 7 p.m.*

### Newcomen Society

LONDON
"A Pioneer Arched Dam: at Jones Fall on the Rideau Canal, Ontario, Canada," by Robert F. Legget. Wed., 19 Nov., 5.30 p.m.

### Pavings Developement Group

LONDON
"Development of Urban Motorways in Brussels," by André Saccasyn; and "Development and Planning of Road Systems in California," by J. W. Vickrey. Institution of Civil Engineers, Great George Street, S.W.1. Thurs., 20 Nov., 3.15 p.m.

### Reinforced Concrete Association

LONDON
"Recent Developments in the Design of Reinforced-Concrete Shell Roofs," by J. D. Bennett. 11 Upper Belgrave Street, S.W.1. Wed., 19 Nov., 6 p.m.*

### Royal Society

LONDON
Annual Report of Council and various short papers. Thurs., 20 Nov., 4.30 p.m.*

### Royal Society of Arts

LONDON
"Improving the Efficiency of the Mining Industry," by H. A. Longden. Wed., 19 Nov., 2.30 p.m.

### Royal United Service Institution

LONDON
"British Shipping—What of Its Future?" by Robert D. Ropner. Wed., 19 Nov., 1.30 p.m.

### Sheffield Metallurgical Society

SHEFFIELD
"Vacuum Melting," by G. L. Willan. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 18 Nov., 7 p.m.

### Sheffield Society of Engineers and Metallurgists

SHEFFIELD
"Progress in Rod and Bar Rolling," by R. Stewartson. Mon., 17 Nov., 7.30 p.m.

### Society of Instrument Technology

LONDON
Symposium on "Analytical Instrumentation Developed at Harwell." Manson House, Portland Place, W.1. Wed., 19 Nov., 2.30 p.m. to 6 p.m.

### South Wales Institute of Engineers

CARDIFF
"German Research in Air-Borne Dust Measurement and Suppression in Coal Mines," by J. R. Hodkinson. Thurs., 20 Nov., 6 p.m.

**The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated.** Particulars for this column should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1. (MUSeum 1901.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, S.W.1. (WHItehall 5536.)
Diesel Engineers and Users Association, 18 London Street, London, E.C.3. (ROYal 2393.)
Faraday Society, 6 Gray's Inn Square, London, W.C.1. (CHAncery 8101.)
Illuminating Engineering Society, 32 Victoria Street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 2 Grosvenor Gardens, London, S.W.1. (SLOane 0469.)
Incorporated Sales Managers' Association, 51 Palace Street, London, S.W.1. (VICtoria 1461.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave Square, London, S.W.1. (BELgravia 3291.)
Institute of Petroleum, 61 New Cavendish Street, London, W.1. (LANgham 3583.)
Institute of Road Transport Engineers, 69 Victoria Street, London, S.W.1. (ABBey 6248.)
Institution of British Agricultural Engineers, 6 Buckingham Gate, London, S.W.1. (TATe Gallery 8589.)
Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George Street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661.)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware Middlesex. (MILl Hill 3543.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria Street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland Place, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield Street, London, W.1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1. (VICtoria 0786.)
Newcomen Society, Science Museum, Exhibition Road, London, S.W.7. (KENsington 1793.)
Pavings Development Group, Terminal House, Grosvenor Gardens, London, S.W.1. (BELgravia 6661.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal United Service Institution, Whitehall, London, S.W.1. (WHItehall 5854.)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865.)
Sheffield Society of Engineers and Metallurgists, University of Sheffield, St. George's Square, Sheffield 1. (Sheffield 24071.)
Society of Instrument Technology, 20 Queen Anne Street, London, W.1. (LANgham 4251.)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296.)

**Design**

# FREE VERTICAL TAKE-OFF AND LANDING

Shown in the accompanying illustration is the Short SC.1 VTOL research aircraft on its first free flight at Belfast on 25 October. The aircraft took off from a small metal platform. It rose straight up to a considerable height and for a while hovered motionless. It then moved forward for some distance before making a successful vertical landing.

This occasion was the first time that the aircraft had flown outside its specially built test gantry, in which hovering trials have been in progress for the past two months. It has now completed the preliminary pre flying trials. The next stage will be to master transition.

The SC.1 is being developed by Short Brothers and Harland Limited, Belfast, under contract from the Ministry of Supply. It is Britain's first all-jet VTOL aircraft project and the only aircraft in the world to rise vertically by means of a downward-pointing battery of engines, and to fly forward by using a separate engine exhausting at the rear. It has five Rolls-Royce RB.108 jet engines, four of which provide the lift.

Stability during hovering is ensured by automatically regulated jets of air from nozzles positioned at the nose and tail and wingtips. The air is bled from the engine compressors and the nozzles are fitted with shutters which automatically close or open to control the volume and power of the air jets. The pilot can, when necessary, take over from the autostabiliser.

With the aid of data provided by the SC.1's research programme Short Brothers are studying the application of vertical take-off and landing to both military and civil aircraft. A glimpse of the possible shape of military operations of the future was provided by a model shown on the company's stand at the Farnborough display. Designed for demonstrating the mobility and quick striking power of VTOL aircraft, the model showed camouflaged aircraft about to take off amid screens of trees in forward areas.

# DEFENCE DEPARTMENTS TO INSIST ON BETTER DRAWINGS

During the Second World War when there was much sub-contraction of the manufacture of service equipment, confusion and duplication of effort frequently arose because of the variation in drawing and manufacturing customs between different industrial organisations. A major step forward in the standardisation of drawings was the issue of B.S.308:52, "Engineering Drawing Practice"—now supplemented, for the purpose of the armed services, by Defence Specification DEF-33, "Preparation of Drawings for Service Requirements," HMSO (7*s* 6*d*).

It is the intention of the Services "to have all drawings of their equipments prepared in accordance with this specification, which is designed to ensure the provision of all the information required to produce an equipment. In this scheme, every drawing number and title can be ascertained, every item can be identified, and every test and specification is referred to; all materials are quoted and every dimension and tolerance is recorded at the stage where it is required to be known. It provides drawing offices, planning offices, workshops and inspection with the information which is required.

To achieve the standardisation of drawing procedure which DEF-33 is designed to accomplish, some drawing offices will have to make changes from the systems which they have been accustomed to use. The fully comprehensive system of DEF-33 may entail that more time is spent in the preparation of drawings. This extra time will be amply repaid in subsequent manufacture and inspection processes as it will eliminate the many queries and sources of error that have existed in other less comprehensive systems. The time spent in the preparation of drawings should be considered time well spent, as the drawings prepared by one man will subsequently be referred to by many men, and if they are clear and comprehensive much time and expense will be saved.

# MANNED RESEARCH AIRCRAFT

## *North American X-15*

The X-15 manned research aircraft, designed to fly above the earth's atmosphere, has now been rolled out of the North American Aviation hangar at Los Angeles, and will be taken to Edwards Air Force Base, California, for flight testing which is scheduled to begin early in 1959. It is expected to fly to a height of approximately 100 miles above the earth, and at speeds up to 3,600 m.p.h. during its research life.

The X-15 flight-test programme is expected to yield information on flight conditions beyond the earth's atmosphere; to increase knowledge of aerodynamic heating and heat transfer from aircraft; and to provide data on control requirements in the near vacuum found at extremely high altitudes, plus the effectiveness of the X-15's primary aerodynamic flight-control, and ballistic control systems during research flights.

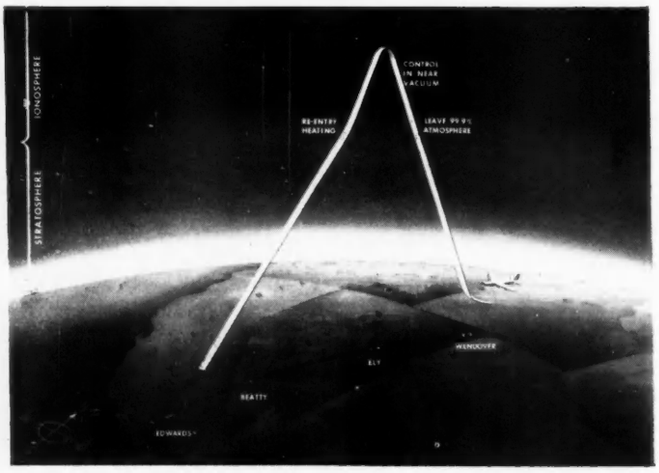
The aircraft, weighing 31,276 lb at launch from the B-52 mother ship, will carry 1,300 lb of instrumentation. It will test man's reaction to space flight, the effects of weightlessness, acceleration and deceleration when leaving and re-entering the earth's atmosphere. A rocket-powered ejection seat affords the pilot maximum protection in the event of bail-out below 60,000 ft.

The X-15 is 50 ft long, 13 ft high, with a wing span of 22 ft. It is fabricated mostly from Inconel-X, titanium and stainless steel to withstand temperatures in excess of 1,000° F. Hydrogen peroxide is used in the ballistic controls system, and as fuel for auxiliary power units to supply electrical and hydraulic power.

Its rocket engines will use liquid oxygen and liquid ammonia as propellents, with a consumption rate of some 20 times that for conventional jet-fighter engines. Thiokol's Reaction Motors Division will supply a rocket engine, the XLR-99, of 50,000 lb thrust. Two XLR-11 interim rocket engines of less thrust will be used on the initial X-15 powered flights. The XLR-11 engine was utilised in the X-1 research aircraft programme. Liquid nitrogen is used for temperature-conditioning and pressurising the pilot's cockpit. The landing-gear arrangement includes a dual nosewheel and steel skids.

North American Aviation Incorporated drew upon the resources of more than 300 American firms in building the X-15.

*The X-15 research vehicle is designed to carry a man 100 miles above the earth at 3,600 m.p.h.*




*Typical X-15 trajectory.*

# PROGRAMME-CONTROLLED SIGNALLING at Watford

THE first programme-controlled railway signalling on a London Transport "surface" line has been installed at the terminal station at Watford on the Metropolitan Line, replacing the mechanical signalling. One sequence and one time machine are employed; together they carry out the following routeing of trains: the reversal of trains of multiple-unit stock in either platform, and their dispatch at the correct departure times; the automatic setting of routes to run the locomotive of a locomotive-hauled train round its train before dispatching it at the correct time; the preparations for the morning service—trains are shunted from the electrified sidings to the running line and then reversed into the platform and despatched at the correct time; the routeing of trains at night and in off-peak periods from the platforms to the appropriate sidings.

*The 36-shaft interlocking machine installed at Watford (Metropolitan Line) controls signals and points. The track diagram is on the right.*

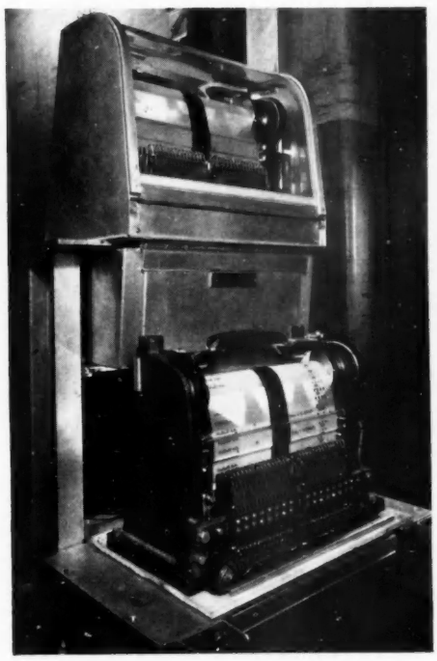
In order to deal with any special circumstance outside the normal timetable working at Watford, the signalman at Rickmansworth, who supervises the working at Watford, is provided with a control panel and has push buttons so that he can route trains at Watford manually should this be necessary. Normally, the programme machines carry out all movements automatically.

Although the programme machines have paths for goods trains included in their programme they do not actually set the routes for these trains. They are signalled by push-button from Rickmansworth, three miles away, the programme machines merely warning the Rickmansworth signalman, by sounding an audible warning in his box, that the trains are ready to proceed.

The programme machines carry a plastics roll on which are typed the details of each train passing over the section of line in sequence. The details are an exact reproduction of the timetable information and include the destination of the train, the train number, and its time. Between the rows of typing, holes are punched in the plastics roll which interpret the information contained in the typescript. Electrical contacts are actuated through the holes to control the signalling equipment. Each train that passes causes the roll to step forward so that the electrical contacts read the next required train operation. The carriage containing the plastics roll in the programme machine can easily be inserted into or removed from the machine so that a different programme roll can be used for weekday, Saturday or Sunday working.

The layout at Watford consists of an island platform with two platform roads, two adjacent electrified sidings outside the platform roads, and a goods yard. The re-signalling work involved the abolition of the mechanical locking frame used previously and the conversion of mechanical signals and points to power operation. The Watford station working is now supervised from the signal box at Rickmansworth and the signal box at Watford has been taken out of commission.

Keys are provided in the Rickmansworth control panel to allow the signalman to "step" the programme machine to the next train position in the event of a train being cancelled, and to allow the departure path associated with that train to be cancelled. Another key will prevent the programme machine from stepping so that an extra train can be handled at Watford without the programme machine getting out of sequence. The extra train must be signalled in and out of Watford under either push-button or automatic reversal control as described below.



*The programme machine installations at Watford. The sequence machine is mounted above the time machine, on which one of the plastics rolls can be seen as well as the row of electrical contacts.*

Apart from programme machine working, facilities for the automatic reversal of trains without regard to timetable operation are provided at Watford. Under this system, the first train to arrive at Watford will be the first to leave, the starting signal being automatically cleared for a train to depart as soon as the platform stop has exceeded four minutes.

There are thus three possible methods of operating the signalling at Watford: programme machine working (normal); automatic reversal; by push button from Rickmansworth.

All signals and points are controlled from shafts in a 36-shaft interlocking machine housed in a new fireproof building between the running lines at the south end of the station. The interlocking machine is provided with mechanical interlocking and with contacts for the control of the signalling circuits. Each shaft is equipped with air cylinders and electromagnets which will be energised by the remote control circuits. Sealed relays of the telephone type are used for the non-safety circuits operating the interlocking machine shafts.

One shaft in the interlocking machine, controlled from a two-position key in Rickmansworth signal box, is provided for the purpose of isolating the goods yard working, enabling the shunter to set points by hand for shunting purposes without interference with the general station working.

In the signal box at Rickmansworth, a push button is provided for the control of each signalled route at Watford if required during a disorganisation of the service or in exceptional circumstances. The push buttons are of the now standard LTE type which are capable of being illuminated green, yellow or red to show whether the signals are clear, or that the route has been pre-selected, or that the signals are at danger.

*One of the chairlock type of point lay-out, showing the electro-pneumatically operated tracklock mechanism.*

An illuminated diagram shows all track circuits in the Watford area together with signal and point indications. The controls and indications between Watford and Rickmansworth are carried in a 217-core cable of the type developed by London Transport with conductors of 0·010 in diameter and a copper screen around the whole of the cores. The circuits are fed by direct current at 100 V, with sealed telephone-type relays at the end of each circuit.

Running signals are of the two-aspect colour-light type and shunt signals of the externally illuminated disc type. Electro-pneumatically operated train-stops are provided at all running signals and certain shunt signals.

For the first time on an appreciable scale on London Transport installations, the points will be controlled by the chairlock type of point layout similar to that employed by the French National Railways, but modified and developed to London Transport requirements. The modifications include the provision of an electro-pneumatically operated ground tracklock which is provided on facing points over which passenger trains operate and a detector which separately detects each switch and the tracklock in the locked position.

This is the first time that the production model of the modified chairlock has been used, and it is applied to 12 pairs of points at Watford. Its

## *Continuing* **Design**

essential feature is that the closed tongue of the points is held firmly clutched to the stock rail when locked. In France, it is used by the SNCF on flat-bottom track and it was therefore necessary to adapt it to the bull-head track used by London Transport. The actual locking mechanism is enclosed in a casting forming part of the chair which supports the end of the switch tongue, so that there is a separate lock for each tongue. This is in contrast to the usual method of locking in this country, which consists of a plunger acting on the stretcher bar.

The drive rod of the layout is connected to two switch-locking arms which pivot at each switch. The locking arms are in the form of cranks, one arm of which is connected to the electro-pneumatic operating cylinder. The second arm is provided with locking faces which engage with corresponding faces in the lock box chair castings to achieve the mechanical locking. Each chairlock is equipped with an electro-pneumatically operated ground tracklock which has to be lifted to allow the switch locking arm to move. The tracklock is locked by the protecting track circuits.

The detector has been redesigned and the detection contacts can only be closed (to allow the signal circuits to be completed) when both switches are in the correct position and locked in that position by the ground tracklocks. The lines are continuously track circuited by means of single-rail condenser feed track circuits. Rail circuits of the 10KC type have been provided to detect that trains passing over facing points have completed their route and that the back-locking requirements have been satisfied. Line cables for connections to signals, trainstops, points and track circuits are of the single and two-core rubber compound lead-covered type. Connections between cable runs and track equipment are carried out with the aid of screened multi-core cables with ribbed Neoprene sheaths. This type of cable has a metal screen around the insulation on each core, and, because of its ribbed sheath, may be laid on the ballast without concrete troughing or similar protection.

The Rickmansworth signal box now controls Rickmansworth itself, the whole of the Watford triangle junctions, and supervises the working at Watford. The work at Watford was devised, planned and carried out by Mr. R. Dell, signal engineer, London Transport, and his staff, to the general requirements of Mr. C. E. Dunton, Chief Civil Engineer, London Transport.

# NON-BURRING SPANNER

## *Grips Flats not Corners*

A new type of spanner, the " Surpans," designed to exert a positive grip on the centre of the flat surfaces of a hexagon nut or bolthead, has been developed by Brades Nash Tyzack Limited, Oldbury, Birmingham.

Hitherto, owing to the play between the jaws of conventional spanners and the faces of bolts and nuts, the tightening pressure was often applied on the corner, as in Fig. 1, often resulting in the deformation of both nut and spanner

Fig. 1

*Fig. 1 With the conventional spanner, the tightening effort bears on the crest angles.*

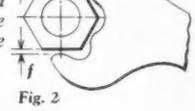



Fig. 2

*Fig. 2 The same margin of play is provided in the Surpans spanner as in the conventional—*

Fig. 3

*Fig. 3 —but when the Surpans grips, the effort bears only on the faces.*

when the applied effort has been excessive. Figs. 2 and 3 show how the shaped jaws of the Surpans spanner avoid this damage.

Fig. 2 shows that the margin between the jaws of the Surpans spanner and the faces of the nut exist just as in the case of the ordinary spanner. Fig. 3 shows that when the Surpans spanner grips, the effort exerted bears only on the faces. If, as may happen, this effort is such as to exert a pressure on the metal beyond the elastic limit, no serious damage can result, for at the most a mark will remain on the nut, accommodating the spanner jaws on some future operation.

Other advantages claimed for the Surpans spanner are that one spanner will grip nuts of several different sizes; that it is easier to handle, and is more robust and less bulky than the equivalent conventional spanner; and that it can grip a bolt with burred angles. Surpans spanners are available in $\frac{3}{16}$ in to $\frac{9}{16}$ BSF and $\frac{1}{8}$ to $\frac{1}{2}$ in Whitworth.

# INCH AND METRIC SYSTEM INTERCHANGEABILITY

*We give below a condensed version of a statement issued by the Engineering Equipment Users Association, 20 Grosvenor Gardens, London, S.W.1*

In recent years there has been a significant move to ensure that the International Organisation for Standardisation (ISO) shall issue ISO recommendations in both inch and metric values. The requirements of the inch-using countries relating to pipes and tubes were brought into prominence at the plenary meeting of Committee ISO/TC5—Pipes and Fittings, held in Stockholm in 1955.

Recently the British Standards Institution Export Panel have placed considerable emphasis on securing agreement on dimensional standards which will provide functional interchangeability between products and components, whether measured in inch or metric units; and, where this is impracticable, to see that the dimensions in inch units are always included on an equal basis with the metric. This has become of prime importance because of the signing of the Treaty of Rome and the formation of the European Economic Community, together with the proposals for a wider free trade area.

As defined by the ISO Standing Committee on Scientific Principles of Standardisation (STACO), functional interchangeability is achieved when those characteristics of the finished product which affect its operation have been standardised to the necessary degree of accuracy. This frequently includes characteristics other than linear dimensions. In most cases the complete standardisation of all characteristics is neither possible nor necessary. Technical committees should therefore study very carefully which characteristics ought to be standardised, and to what accuracy.

It is difficult to obtain international agreement on dimensional standards which will satisfy the requirements of countries using inches and pounds and those using millimetres and kilograms. There is a tendency for each country to retain its own system, and a natural liking for round numbers. However, many of the present discrepancies could be resolved by much closer attention to the real significance of figures, rather than their expression in one system of measurement or another. This concept was the basis of the workable solution which was put forward by the British delegation at Stockholm in 1955 and which is referred to as the use of " corresponding " values.

This system consists in expressing a dimension both in inches and in metric units to a sufficient degree of accuracy to ensure practicable interchangeability. Thus, if only approximate accuracy is required, reasonably round numbers can be used in both systems. For example, for the length of a tube, 7 metres can be taken to " correspond " to 23 ft; similarly, 0·176 in (7 s.w.g.) is sufficiently close to 4·5 mm to provide interchangeability where pipe thickness is concerned. On the other hand, the dimensions of a screw thread gauge may well have to be given to several places of decimals to ensure exact interchangeability. It is therefore necessary to consider how accurate the equivalents of the metric and inch units have to be to ensure adequate interchangeability.

# PATENTS LAWS IN THE CHANNEL ISLANDS

*The following notes on patents, designs and trade marks laws of Jersey and Guernsey are abstracted from information supplied by a Member of the Institute of Trade Mark Agents.*

It is a mistaken belief, held by many people, including manufacturers and traders in Great Britain, that British patents, design registrations and trade mark registrations granted by the London Patent Office under the Laws of the United Kingdom of Great Britain and Northern Ireland, extend to and afford protection in Jersey, Guernsey and the other Channel Islands.

The owners of many thousands of world-famous and other valuable trade marks seemingly think that their trade mark rights are fully protected by virtue of their United Kingdom trade mark registrations, but this belief is incorrect. Only the obtention of fresh trade trade mark registrations (and patent and design registrations, as the case may be) under the new Statute Laws, namely, the Patents (Jersey) Law, 1957, the Registered Designs (Jersey) Law, 1957, and the Trade Marks (Jersey) Law, will afford such protection in Jersey.

Similarly, owing to lack of knowledge concerning the legal situation, many thousands of unregistered trade marks are being used in Guernsey. Full protection in respect of such trade marks can be obtained only by registering same under the Statute Law of Guernsey.

In both Jersey and Guernsey, patent protection may be obtained only by first obtaining the grant of a British (United Kingdom) patent and then registering it in Jersey, or Guernsey. No proceedings for infringement may be instituted in respect of acts committed before the date of registration. A similar arrangement applies to the registration of trade marks, only those that have been registered by the London Patent Office in the British Register of Trade Marks being eligible for registration in the Channel Islands. In Jersey, trade marks registered prior to 1 July, 1958, when the Trade Marks (Jersey) Law 1958 came into operation, are virtually valueless.

It is a punishable offence to sell in Jersey any article falsely indicated as being patented or registered in Jersey, or to falsely represent a trade mark as being registered in Jersey when it is not so registered.

**Research and Development**

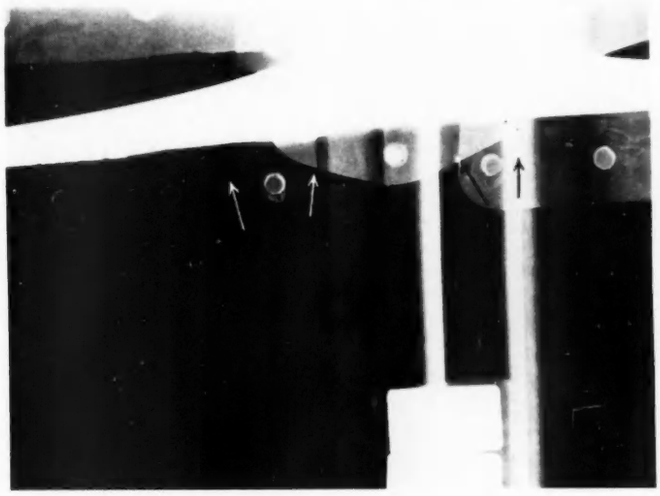
# DEVELOPING INSPECTION TECHNIQUES *for* AIRBORNE COMPONENTS

To maintain the standards of military aircraft and guided-weapon equipment, the Ministry of Supply employs, in the Aeronautical Inspection Directorate, some 1,000 inspectors and engineers. The "back-room boys" of the AID—those who work in the laboratories at Harefield, Middlesex—have recently been showing some of their activities to the aircraft industry and the technical Press at a series of open days. They serve in part as a training centre for AID staff, but their main functions are twofold—to check samples and investigate failures submitted by the AID inspectors attached to the manufacturing firms; and to develop new techniques of inspection to keep pace with new materials, construction methods and equipment as they are introduced into production.

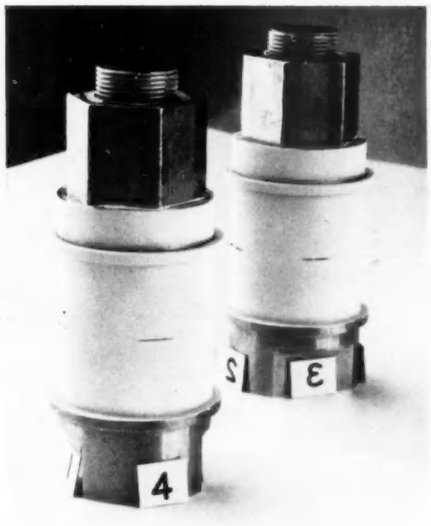
To this end, the Laboratories have a fine array of high-precision instruments and test machines; there are departments of metallurgy, metrology, non-destructive testing, guided weapons and textiles. Also housed at Harefield are the physics, and radio and electricity, sections of the Ministry's Inspectorate of Electrical and Mechanical Equipment, and a section of the Chemical Inspectorate, who also play their part in ensuring the overall acceptability of airborne equipment for the Services. The range of work done is thus very wide; here, we shall mention only a few typical examples.

The fostering of new inspection techniques is, in particular, very much the concern of the non-destructive testing and the metrology sections. Throughout the aircraft industry, radiographic techniques are now well established, and are in fact mandatory for the examination of major castings and forgings. There is increasing interest in the use of radiography for examining assemblies, both small and large, as for instance, inaccessible parts of aircraft structures; structural radiography is, however, still in its infancy, and at Harefield the radiology section are endeavouring to assess the dependability of the method for detecting cracks, by carrying out a complete radiographic examination of a tailplane assembly, which will be subsequently stripped down and inspected visually, for correlation with the results of the radiographic inspection.

*Cracks inside a tailplane structure revealed by radiography.*



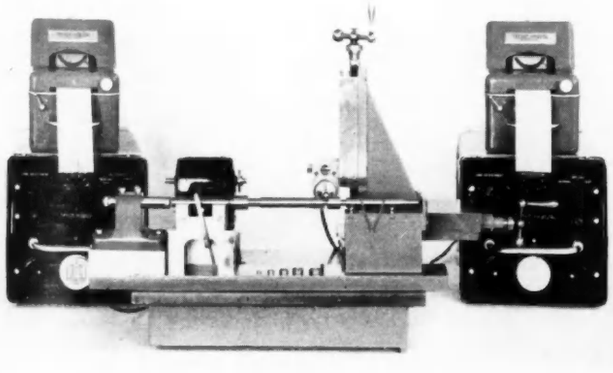
Magnetic flaw detection and penetrant flaw detection methods, too, are well established. The success of the latter for the surface examination on non-ferrous metals is in large measure due to Harefield's work in the evaluation of the penetrant fluids. For this purpose, they have developed a demountable artificial "defect" which can be cleaned before each individual test and re-assembled to produce identical conditions. The test piece is shown in an accompanying illustration. The mating faces of the two steel sleeves are lapped, and four areas on the periphery of one of the faces are relieved below the general level to the extent of 0·0001, 0·0002, 0·0003 and 0·0004 in respectively. When the lapped faces are clamped together with an intervening layer of soft metallic foil, the four recesses constitute artificial defects of varying widths. Using a standard procedure for cleaning and assembling the test piece, good reproducibility of results has been obtained for any particular penetrant, and the method has proved to be of considerable value in assessing the efficiency of different penetrant processes.




*Demountable artificial "defect" for evaluating penetrant fluids.*

Although some aircraft firms are making good use of ultrasonic testing, this is not yet a technique that is in general acceptance. At Harefield, a considerable variety of ultrasonic testing experience has been built up, both for the detection of internal flaws and for thickness measurement, and they have now to convince the more conservative manufacturers that the successful handling of ultrasonic apparatus does not, in fact, demand the services of highly skilled technicians. Still largely in the exploratory stages is the use of eddy current methods for sorting tube and bar steel and for thickness measurements of surface coatings.

Improving methods for checking accuracy of high-precision miniature ball bearings is one of the subjects concerning the metrology section. Diameter measurements of the steel balls themselves can be made to an accuracy of $5 \times 10^{-6}$ in on an instrument devised at Harefield; and they have recently developed apparatus for checking the running accuracy of assembled ball bearings, which hitherto has been assessed—with doubtful validity—from the results of separate measurements of side wobble, track wobble and eccentricity. The principle of the apparatus is that the combined effect of all the errors in a bearing will cause the rotating ring to oscillate in either, or both, radial and axial directions. The bearing is mounted between two shafts, one of which acts as a stationary member and the other as a rotor, thus simulating operational practice. The shafts can be transposed so that tests may be carried out with either the inner or outer ring of the bearing rotating under radial load. A third shaft, mounted co-axially, supports the opposite end of the rotating shaft and provides means of applying a thrust for tests under axial load. A series of sleeves and mandrels is available so that various sizes of bearings can be accommodated. The rotating shaft is driven by an electric motor and the axial and radial oscillations resulting from the composite effect of errors in the bearing are picked up by measur-

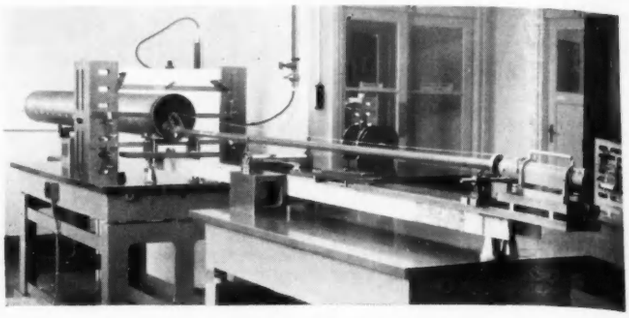


*Apparatus for checking the running accuracy of assembled miniature ball bearings.*

## *Continuing* Research and Development

ing heads and graphically recorded at high magnification.

Another example of inspection apparatus devised by the metrology section, shown in the accompanying illustration, is a mechanical/optical instrument for measuring the wall thickness of a long tube. A stylus and mirror target, mounted on a support tube universally jointed to the instrument frame, are traversed through the tube, and any displacement of the target from a preset standard, due to thickness variation, is observed through the bore of the support tube by an alignment telescope.



*Apparatus for measuring the wall thickness of long tubes.*

In this brief review we have concentrated, perhaps, on the more obvious aspects of aircraft inspection development; it remains to mention briefly one or two other sides of the work at Harefield. The introduction of guided weapons is posing many new problems, one of which is a requirement for endurance testing weapon assemblies under conditions of resonance. In cases of sealed assemblies, resonant frequencies cannot be detected visually, and audible methods are not reliable. Therefore the guided weapons section at Harefield are now working out an electronic method for this purpose. Their method of attack is to measure the load applied to a vibrating assembly to maintain a constant amplitude: at resonant frequency, this load is, of course, diminished. The applied force is measured by means of a thin-walled strain-gauge load cylinder. An interesting fact that this technique—which is still in the early stages—has revealed is that audible methods of determining resonant frequencies tend to give false indications—the frequencies thus identified as resonant are, in fact, slightly lower than the true resonance peaks as revealed by the new method.

Finally, a brief mention of the textiles section which deals not only with textiles for flying clothing, parachutes and harness, but also with structural textiles such as glass fabrics and mats, and ropes. The tensile testing of continuous filament glass fabrics has given difficulty, normal methods usually resulting in breaking on the inner edge of the grips. To overcome this, the staff at Harefield have developed a method of reinforcing the ends of the glass-cloth specimen with stiff paper and rubber solution, which adequately protects the glass filaments from damage in the grips; the backing paper serves to prevent distortion and uneven tension.

## *Equipment Shown at Mullard Exhibition*

# MICROWAVE ADVANCE

Some of Mullard Limited's recent developments in the field of radar and microwave communications were displayed at an exhibition held at the company's headquarters—Mullard House, Torrington Place, London, W.C.1. Specialised valves and tubes for radar, and micro-wave equipment made up the display, which was held expressly for representatives of government departments and the radar and communications branches of the electronics industry. In addition to working demonstrations, visitors were able to hear various papers read by members of the Mullard Research Laboratory, Salfords, Surrey.

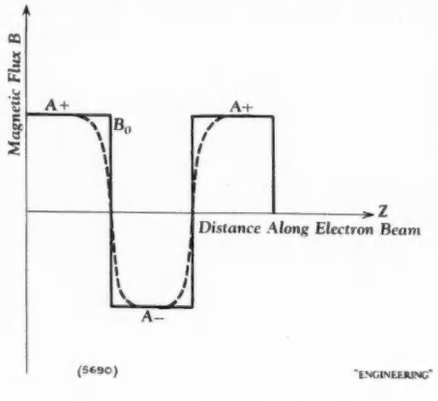
The working demonstrations included a voltage-tuned broad-band microwave signal source using a backward-wave oscillator. The following frequency ranges could be covered: 7-11·5 kMc/s at a power level not less than 20 mW, and 11-18 kMc/s at a power level not less than 10 mW. The equipment could be operated with amplitude modulation, frequency modulation, or simply as continuous wave. In broad-band measuring techniques the equipment may be used for reflectometer measurements of voltage standing-wave ratios, for frequency-gain characteristics of travelling wave tubes, amplifier klystrons, etc., and in conjunction with a travelling-wave tube as a stabilised high-power broad-band source. The frequency-power curve at a waveguide detector may be observed on a built-in oscilloscope, with the line sweep voltage utilised for X-deflection. On continuous wave operation a suppressed-zero meter enables the line voltage to be reset to within 2 V over the whole range, giving accuracy in frequency resetting and in the measurement of incremental frequency changes. The equipment is a compact under-bench unit.

A travelling-wave tube was demonstrated in a system for producing small frequency shifts at microwave frequencies. As such it has use in testing radar and Doppler systems. The shifts were produced by superimposing a sawtooth waveform on the helix voltage. If the amplitude of the sawtooth waveform is sufficient to produce a phase shift of $2\pi$ and the flyback time of the sawtooth is small, then the output from the travelling-wave tube can be made to suffer an apparently continuous advancement or retardation in phase. Such action produces a frequency shift without producing unwanted sidebands—such as are produced if a sine wave is used instead of a sawtooth.

The frequency shifts that can be realised are lower than those producible by sine-wave modulation, owing to the difficulty of producing high-frequency saw-tooth waveforms. But frequency shifts up to 1 Mc/s with a sideband rejection of better than 20 dB have been found feasible.

The recently developed technique for reducing the weight of permanent magnets used to focus electron beams was also shown. The reversing field system uses the same weight-saving principle as do periodic focusing systems but overcomes many of the disadvantages of it. The way in which the system operates, however, can be more readily understood by comparison with unidirectional field systems than with periodic systems. If a uniform magnetic field $B_0$ is required to confine an electron beam within a given drift tube, then the beam could be focused equally well using the field distribution indicated by the solid line $A_+$ $A_-$ shown in the drawing, as the confining forces on the beam are determined by the square of the axial component of the field. Any number of field reversals could be used and they need not be periodically arranged along the beam.

*Introduction of field reversal into a permanent magnet system for focusing electron beams results in considerable weight saving. Two reversals are shown in the diagram.*




Perfectly sharp reversals cannot be achieved in practice, since there must be a transition region of finite length between each region of uniform field. The conditions under which a beam can be focused using such a reversing system will be largely determined by its behaviour in the transition region. This can be calculated by considering the transition region to form part of a Glaser lens system; it can be shown, for example, that using practicable magnet and pole-piece configurations, the limiting perveance for which the method can be used is about $30 \times 10^{-6}$ $\mu$ perv. in the case of klystrons and about $10 \times 10^{-6}$ in the case of travelling-wave tubes.

The method is used to greatest advantage in klystrons using long, high-power beams, as for such purposes the only practicable alternative at present is the unidirectional field method, for which the permanent magnets required would be excessively large and heavy. Under development in the Salfords Laboratories is a high-power klystron which uses an electron beam of perveance $1{\cdot}0 \times 10^{-6}$, diameter 5 mm, length 100 mm and operating voltage 60 kV. This has been focused in coils giving a field system with one reversal at voltages up to 1·3 kV using field strengths approximately the same as those required for unidirectional field focusing. Since the fields scale as the square root of the beam voltage in both cases, it can be predicted that the same relation will exist at high voltages. A permanent magnet has been designed and built to give the field distribution required at operating voltage. This magnet weighs 45 lb. The present conventional permanent magnet used for the valve weighs 200 lb.

**Metals and Materials**

# COPYING RADIOGRAPHS FOR REPRODUCTION

*By R. O. Couchman,*
*Chief Radiologist,*
*Kent Alloys Limited*

THE ability to produce radiographs in a form suitable for reproduction as half-tones or as prints for attaching to reports, is an essential job in every radiological laboratory. Reproducing any form of transparency on paper presents difficulties, and the high contrast found in radiographs, particularly industrial radiographs, adds to the problems encountered. A radiograph has a contrast range, when viewed by transmitted light, of maybe 1,000 to 1, while the maximum range that can be produced from paper prints, using reflected light, is in the region of 50 to 1. It is necessary, therefore, to reduce the contrast of the original radiograph before satisfactory reproduction can be obtained.

Methods of producing paper prints with suitable gradations may be classified in three groups, namely: by printing from a radiograph with some form of contrast control; making a paper radiograph; and by photographing the original radiograph and printing the resulting "positive" on bromide paper.

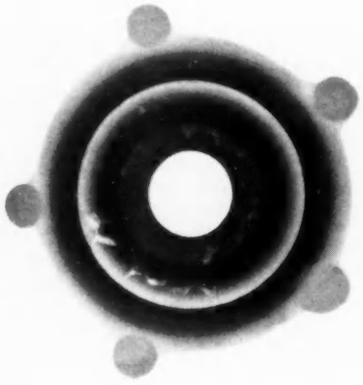


*Fig. 1 Positive print from a radiograph. In this reproduction, all tones are reversed and shrinkage cavities are shown "white" in the centre area.*

The first method is the least satisfactory, in that it gives a reversal of tones. Cavities which appear in the original radiographs as dark marks are shown on the prints as white. As all radiographers have been trained to read direct from negatives, this reversal of tones naturally leads to confusion and often to a false assessment of the readings. Further, it will be realised that the excessive contrast of radiographs cannot be reproduced on to paper without a considerable amount of "dodging" by shading. This dodging can be achieved by shading with the hands or by making a supplementary positive, somewhat less dense than the original negative; placing the two together in register, but slightly out of contact; and then printing. Both these methods require a considerable amount of experience and the work involved is considerably more than is required by the third method mentioned, and, at the same time, they provide only inferior results.

A fairly simple method of obtaining negatives suitable for direct printing is to remove half the emulsion. This process is possible with radiographs as the film base is covered with emulsion on both sides. The radiograph is secured by its edges, with Sellotape, to a sheet of glass. Caustic soda solution is liberally swabbed on the emulsion and, after a short soaking, the emulsion is softened and easily removed. The radiograph is then taken off the glass plate, washed and dried. It will be found that the radiograph now has a contrast equal to approximately half that of the original. Such a radiograph can be printed direct on to bromide paper in the usual manner and the accompanying illustration, Fig. 1, was obtained by this method. However, when this method is used it should be clearly stated that the paper print is a *positive* and that all tones are reversed.

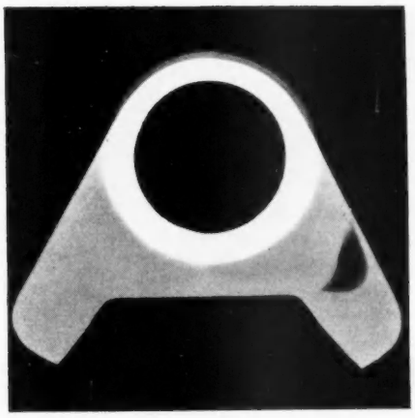


*Fig. 2 (above) A direct radiograph printed on to bromide paper. A large cold shut is to be seen at the junction of the right-hand arm.*

If only one or two copies are required and the defects are of a fairly coarse nature, an adequate result can be obtained by radiographing direct on to paper. While not giving such good results as the third method mentioned above, it has the advantage of being cheap, as film transparencies are not required. Most film manufacturers make special X-ray paper, but in the laboratories of Kent Alloys Limited somewhat better results, for reproduction purposes, have been obtained by using single-weight bromide paper with a glossy surface.

In this method, a rigid cassette is employed to hold the sensitive material. The front section of a pair of high definition salt screens is placed in contact with the sensitive side of a sheet of bromide paper. In turn, this is placed in the cassette so that the salt screen and the sensitive side of the bromide paper are facing the rays. The image is produced by X-rays causing the fluorescent screen to emit light rays in proportion to the amount of rays striking the salts, which glow under the rays' influence. It is advisable to put a sheet of black paper behind the bromide paper in the cassette, so as to stop any back reflection of light. The paper is subsequently developed in the normal way. As a rough guide for a trial exposure, the same kilo-voltage can be used as in normal radiography with some four to five times the exposure time. Fig. 2, was obtained by this means, but it must be remembered that for every print a separate exposure must be given.

The only really satisfactory method for obtain-

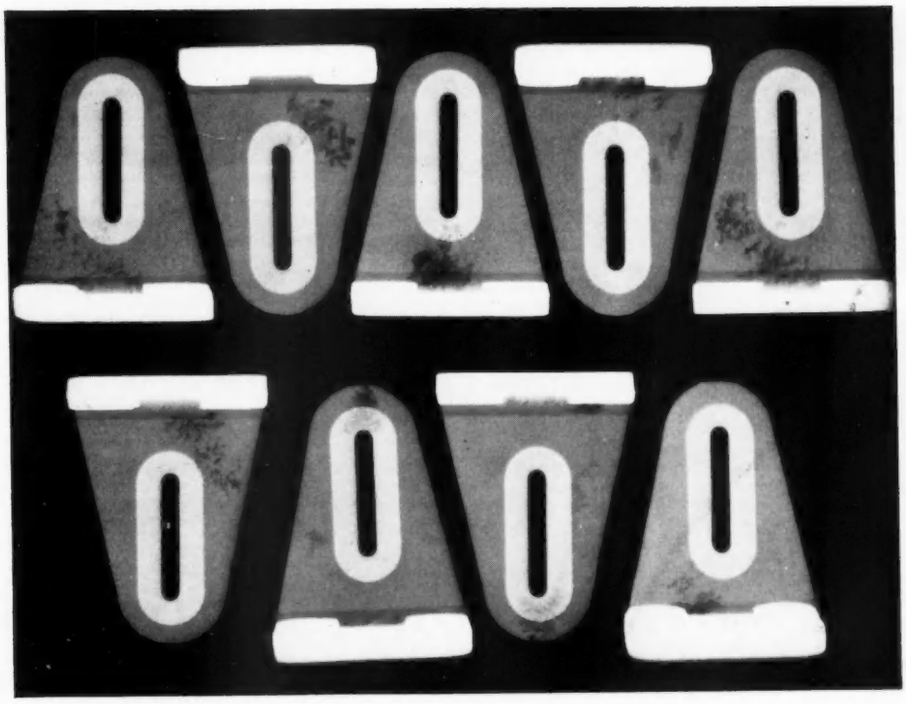


*Fig. 3 (below) A radiograph of a batch of diecastings. This print was obtained by photographing the original. Each casting shows areas of shrinkage of a filamentary character.*

*Continuing* **Metals and Materials**

ing an unlimited number of prints, giving maximum detail in all densities and allowing the operator full control over the result, is by photographing the original radiograph and printing the resulting positive on to bromide paper through an enlarger. For the best results by this method the following equipment is ideal: an X-ray illuminator, preferably with four sliding masks; a camera with long extension bellows and ground glass screen; and a stand to hold the illuminator and carry the camera on a sliding base for focusing, at the same time keeping the camera square with the illuminator.

Alternatively, a small camera with a near-focusing device may be used with the camera held on a rigid tripod. In such cases, it will usually be found easier to slide the illuminator on a table for focusing, but special attention must be paid to see that the illuminator is perfectly square with the camera. The illustration of a batch of die castings, Fig. 3, was obtained with this apparatus.

The radiograph should be placed in the centre of the illuminator and held in position on all four sides with masking tape. This process will hold the film flat and repress the halo of light which generally leaks from the edge of the film after the masks have been brought into position. It will be found best to use the centre of the illuminator as the light often decreases towards the edges. If the illuminator has only three masks it will be necessary to use a sheet of black paper to screen the glare from one side. Focusing is sometimes difficult, but a hair stretched tightly across a light section of the negative will be seen easily on the ground glass. Care must be taken, of course, to see that the hair is removed before exposure.

A direct reading from a section of mean density with a photo-electric light meter placed close to the film gives a correct exposure. As a guide, when using fast panchromatic film, two seconds at F.22 is suggested for a trial exposure, and it is advisable to work in a darkened room to avoid reflections from the surface of the radiograph. The film should be processed according to the makers' instructions, except that it is advisable to reduce developing time by one-quarter and so obtain rather less contrast.

If fairly slow orthochromatic plates are used (which can be developed in a safe-light), very excellent positives may be produced by developing in the following manner, using two dishes, one containing developer and the other plain water. The plate is first placed in the developer for one minute, rocking the dish continuously. It is then removed, quickly drained, and placed in the clean water for one minute *without* rocking. It is then immersed and agitated in the developer for a further minute and again for a minute in the static water. This routine is continued until the total time in the developer is that recommended by the makers, with obviously equal time in the water. It is finally fixed, washed and dried. By this means an excellent positive is obtained with great detail in the highlights.

It will be appreciated that normal development takes place in the developer. When the plate is removed and placed in water an amount of developer is retained in the swollen gelatine emulsion. The dense portions of the positive quickly exhaust this developer, while the highlights, which exhaust the developer much less rapidly, continue to build up.

The aim is to produce a " soft " positive with detail in all tones. A negative print can then be made either by contact printing or by enlarging on a suitable grade of bromide paper. It is generally an advantage to use an enlarger, even for a print of the same size, or even smaller, than the positive, as some shading will be necessary owing to the fact that very few illuminators give even illumination over a large area. Once a positive has been obtained it is a simple matter to make as many prints as may be required.

# PRODUCING METAL SPRAYED BEARINGS

It is known that the surface layer of bearing surfaces may be obtained by spraying metal on to the base. The surface thus obtained can be adapted to many purposes and can be made to yield good properties under adverse conditions. Yet such bearings are not in general use because of the tendency of the surface layer to detach itself from the base.

To avoid this defect, attempts have been made to arrange adhesive layers between the base and the bearing surface. In one method, the base to be coated is immersed in a bath of solder, after which the bearing metal is sprayed on, producing an alloy compounded of bearing metal and solder. This method has not proved altogether satisfactory because the liquid solder tends to be driven away by the bearing metal, as it is sprayed on. According to another proposal, an intermediate layer of metal is sprayed on to the base and the bearing surface layer is then sprayed on. The bearing thus obtained is heated to about 700° C in the protective atmosphere of an inert gas. This last step, which prevents oxidation at the elevated temperature, makes the method somewhat cumbersome.

A development of the method, which avoids oxidation by a different technique, has recently been patented. In the process, the base has a coating applied to it by dipping or electro-plating. An adhesive coating is sprayed on, under certain conditions, and the bearing surface is sprayed on after. Besides a mechanical attachment between the layers, thermodiffusion takes place, leading to the formation of an alloy between the contacting surfaces. The unity of the various layers is demonstrated by the clear steady note a completed bearing produces when struck.

For the bearing layer, all feasible metals and alloys can be used—tin, lead, aluminium, etc. The total thickness of the layers can in many cases be 0·5 mm; the optimum thickness of the bearing layer (which is sprayed on and turned down to size) is 0·3 mm, the maximum is 1·2 mm. The solder and adhesion layer together make up about 0·2 mm. For the base, the most economical metal or alloy can be chosen, for example, iron (including mild steel, or chromium and manganese steel), Duralumin, copper alloys, etc. It is claimed that the effective combinations of various metals and alloys to be used in the several layers are worked out in a system covering all the metals in the periodic table. In practice the choice is limited because of bearing and economic requirements.

One result of the action of spraying the surfacing metal is that a porous bearing surface is produced, with a maze of interconnecting channels, making for good hydrodynamic lubrication. The finished bearings are of course, subject to normal corrosion risks, varying according to the metals employed. Temperature resistance is good, but again depends on the materials.

An important item in the equipment for producing the bearings is a spray gun having a controllable method of spraying. Initially, a standard type taking 2 mm wire was combined with the turning and feed section of a lathe. This system was gradually improved and special equipment has now been developed. The spray gun will take either air and propane gas, or air and compressed industrial (coal) gas. Any compressor will do for the air but an efficient oil filter must be fitted. The remaining equipment is standard: a hot dipping pot (350° C) and a furnace (200° C). By mixing certain materials with the sprayed metal the sliding properties of the bearings can be improved. For such applications, a spraying wire with a core of the required substance is used.

The process can be used for manufacturing solid bearings and band bearings, the latter being shaped to any form. Bearing pressures up to 300 kg per sq. cm can be accommodated, and speeds between 10,000 r.p.m. and 2 ft per sec are feasible. Very small bearings cannot be sprayed inside, the practical limit being about 10 mm inside diameter. It is possible to make repairs on the spot, for example, on heavy bearings in ships, without demounting.

It is believed that full automation of coated bearing production is possible, using presently known techniques. Licences and know-how are being made available to manufacturing companies. Companies interested can apply to Dr. B. V. de G. Walden, 10 Kensington Gate, London, W.8, or to the inventor, Dr. C. G. D. Maarschalk, Zomerluststraat, Haarlem, Netherlands.

## PLASTICS AMBULANCE BODIES

New ambulances of the London County Council are practically half the weight of the earlier vehicles and are making possible a considerable saving in running costs. These and other advantages have resulted from a body design making use of reinforced plastics mouldings.

Polyester resins for the mouldings were supplied by Beck, Koller and Company, 110 Cannon Street, London, E.C.4, an English affiliate of Reichhold Chemicals, Inc. (USA). Reinforced with glass fibre, the mouldings have greatly reduced the noise inside the ambulance. The plastics surface never has to be painted. If the body is accidentally damaged, repairs can be effected at very low cost.

The complete ambulance unit was designed by Mr. J. D. Burton, transport Officer of the supplies department of the London County Council, and was built under the supervision of Mr. W. S. Grove at the Council depot in London.

## INVITATION TO ESSAYISTS

It does not always pay to sit and think, for it is during such moments that one is likely to be struck by distressing realities, such as the damage which results every year from nature's own demolition agent—corrosion. The fight against it is a continuous one, and is being supported to the last by the Corrosion Group of the Society of Chemical Industry. A little time allowed for sitting and thinking on this subject should, however, prove very rewarding because the above organisation is again inviting essays on the subject of corrosion of metals and its prevention, for submission in a competition which is open until 31 March 1959, to writers who are under 27 years of age on that date.

Suggested length of the essay or paper is 4,000 words. The successful writer will not only receive 25 guineas, but will probably be invited to publish his contribution and to deliver a lecture on the subject. The judges will be happy to receive entries varying in their approach from original research to discussion on practical problems in prevention of corrosion.

Interested persons should contact the following address to obtain complete details of the competition: Education Panel, Corrosion Group, Society of Chemical Industry, 14 Belgrave Square, London, S.W.1.

**Production**

# CLEAN PRODUCTION

Transistor manufacture must be carried on in conditions of extreme cleanliness, for the presence of even minute quantities of dirt or foreign matter in a transistor would have a serious effect on its reliability. Very elaborate precautions have therefore been taken in the new factory of Semiconductors Limited, Swindon, Wiltshire, to ensure that clean conditions obtain at all times. The factory is windowless, and all air entering it is fully filtered and maintained at a constant temperature and humidity.

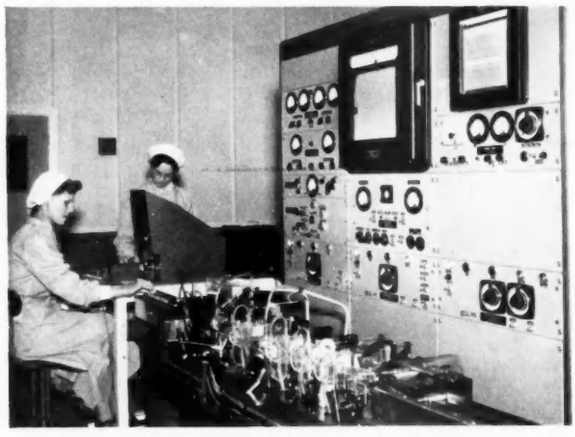
Semiconductors Limited was formed in 1957 as a joint venture by the Plessey Company Limited, Ilford, and the Philco Corporation of America, to manufacture high-frequency germanium and silicon transistors by the Philco electro-chemical process. Some of the key equipment was flown over from America, and some was made by the Plessey Company, and by July, 1958, production of transistors had started at Swindon. Ample room has been left at the factory for expansion, and it is intended at a later date to extend the range of transistors made.

The factory is of two-storey construction, steel framed and aluminium alloy clad. Production is carried out on the upper floor, the whole of the lower floor being devoted to equipment for producing the various services required. Labyrinth passages are provided at the entrances to the production areas, with air curtains to "brush" down anyone entering, and the air in the building, supplied from air-conditioning plant in the basement, is at a slight positive pressure. Draughts, and the dirt they could bring in with them, are thus prevented. Thirteen separate air-conditioning units are provided, each with mechanical and electrostatic filtering, to serve the thirteen zones into which the factory is divided, and the temperature is controlled to within $\pm 1^{\circ}$ F. Refrigeration plant is installed for cooling the air during hot weather, and town gas fired boilers provide heat in the winter. Humidity is controlled by $\pm 5$ per cent, and the dust content of the air is kept to less than one cubic micron per cubic centimetre.

All the internal surfaces of the factory are coated with polyvinyl chloride, to give a smooth surface which will not hold the dust, and all services are brought into the building in concealed piping either through the floor or over the ceiling, as in the case of the air supply. Built-in vacuum cleaner points all over the factory enable cleaning to be done continuously. The equipment in the basement includes, in addition to the boilers and air conditioning plant, air compressors, vacuum pumps, and plant for the production of de-ionised water. This water, which is of 18 million ohms/cm resistivity, is used for washing components in the production area. Argon, nitrogen and hydrogen are also piped through from the basement for use in the production processes, and there is a supply of 60-cycle current for operating the American machines. Fluorescent lighting throughout the factory provides a high standard of illumination.

*There are no windows in the Semiconductors transistor factory. Air conditioning and dust control provide an exceptional standard of cleanliness.*

*Germanium crystals are made in a radio-frequency heated "pull" furnace.*



*Several of the key operations are performed in a transfer line, which also applies electrical tests.*

*After assembly and drying the tops of the transistors are welded on in an atmosphere of nitrogen.*

## CRYSTAL PRODUCTION

The first stage in transistor manufacture is the production of germanium crystals. Purified germanium (refined to an impurity content of less than one part in $10^8$) is melted in a crucible by radio-frequency heating, and a measured amount of antimony is added to give the required electrical characteristics to the finished crystal. A silica tube filled with argon surrounds the crucible. With the germanium maintained at just above its freezing point (about 900° C) a small "seed" crystal is dipped into it. As it is withdrawn, the metal crystallises on the seed to form a single crystal. Both the seed and the crucible are rotated continuously to obtain a uniform temperature distribution.

After electrical tests the crystal (a typical one is 8 in long and 1 in diameter) is sawn into thin discs by a diamond-impregnated wheel. The discs are then lapped in a planetary lapping machine to give them a uniform thickness, and since the lapping abrasive tends to disrupt the crystal structure on the surface of the germanium, the discs are next chemically etched in a nest of rotating plastics beakers.

A special-purpose machine is then used to scribe, with a diamond point, parallel lines on the surface of the germanium discs, and to crack the discs into a series of strips. A second machine, of similar pattern, breaks the strips into small rectangular blanks, which are sorted automatically by a roller thickness gauge.

Transistor stems, which consist of three wires sealed in glass in a metal ring, are mounted in work carriers, which are used as indexing fixtures for later precision operations. This is the commencement of the assembly sequence, the next operation being the welding of a small rectangular nickel tab to the centre wire. A germanium blank is then soldered to the nickel tab, and the partly assembled component is checked in a projection comparator for dimensions and part location.

An automatic transfer machine is next in the production line, and this performs three key operations, as well as intermediate washing, drying and testing. After a preliminary wash in

*Continuing* **Production**

de-ionised water, the assembly moves to the rough etch position, where two jets of electrolyte impinging on opposite sides of the germanium wafer produce concentric pits in the surface.

Precision etching follows. For this purpose the machine has a single jet with an infra-red monitoring beam. The intensity of the infra-red transmission is determined by the thickness of the germanium at the bottom of the pit, and a detector on the opposite side feeds a signal to a servo-amplifier which stops the etching when the required thickness is reached. An autographic recorder enables the progress of each etching cycle to be observed. A second washing follows, and the assembly moves to the precision plating position. Here, indium electrodes of the required diameter are automatically deposited in the etch pits. Washing and drying with hot nitrogen follow and the assemblies go to a position where contact is made with the indium electrodes and an electrical check, chart recorded, is made.

### SEALING

Two small nickel wires, or "whiskers," are next soldered to the electrodes. For this purpose the assemblies pass to a specially designed machine which prepares the wire by plating a prepared amount of solder on the end, bending the wire to the required shape and cutting it from the spool. When a partly-assembled transistor is fed to the machine the wire is located automatically on the centre of the electrode and soldered by radiant heat. The whisker wires are then welded to the stem wires. This is a simple non-critical operation and is performed manually under a magnifying glass.

Chemical cleaning and rinsing with de-ionised water are the next stages in the process, and the transistors are then baked in a vacuum oven to remove all traces of moisture. From the oven the transistors go directly to a nitrogen-filled "dry-box." Here the caps, which have previously been filled with silicone grease, are welded on under manual control. The transistors are thus hermetically sealed before they emerge into the atmosphere.

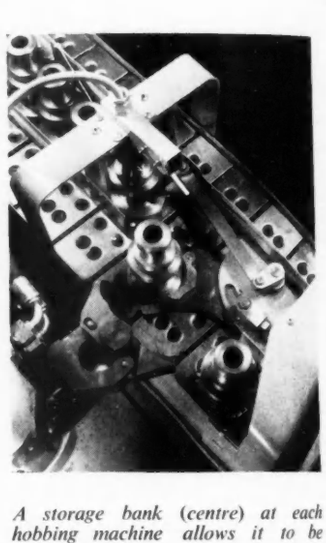
Completed transistors pass to the final test bay, where they undergo comprehensive electrical checking. A proportion of each batch goes for life test, some being run at maximum rating while others are tested at elevated temperatures to simulate, in a relatively short time, a long period of normal operation. Provided that these tests are successful, type numbers are printed on the rest of the batch, which is then ready for sale.

# AUTOMATIC GEAR PRODUCTION

Churchill Gear Machines Limited, Blaydon-on-Tyne, County Durham, introduced automatic loading and conveying equipment for use with their gear hobbing machines some time ago, and a transfer line using this equipment was built in 1957 (ENGRG., Vol. 183, 1957, p. 172). The process of automatic manufacture has now been taken much further, and the Churchill "Link-Line," just completed at Blaydon for a motor car manufacturer, incorporates six different types of machine tool, together with washing and gauging stations. It takes machined blanks for four-speed automobile gearbox layshafts at one end of its 175 ft length, and delivers them at the other end with all the gears (three helical and one straight spur) cut, chamfered, shaved, cleaned and size checked, ready for heat treatment. Some of the operations required in the machining sequence call for machines not made by Churchill Gear Machines, and other manufacturers have co-operated in the equipment of the complete line. There are 18 machine tools in all. An important feature of the conveying and loading gear linking the machines is that it is built up from standard components. The control circuits are also standardised.

A bank of five Churchill rigid hobbers occupies the first part of the line. Two of these machines hob the fourth speed gears, two deal with the third speed, and the remaining machine cuts the first speed. This use of two machines for each of the larger gears allows for the required production rate in spite of the difference in gear sizes and therefore in hobbing times.

*Layshaft blanks are loaded on to the conveyor by hand. Afterwards, the components are handled mechanically.*



*A storage bank (centre) at each hobbing machine allows it to be run when the previous one in the line is stopped for tool changing.*

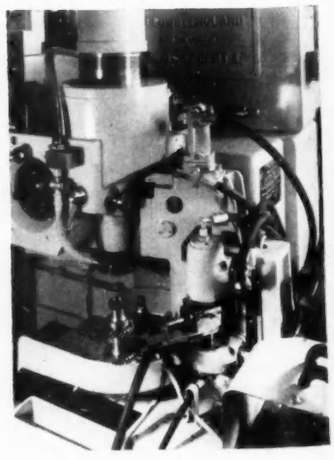
Layshaft blanks are loaded on to the conveyor by hand, and they travel, with their axes vertical, to the first hobbing machine, where they form up in a line to provide a small storage "bank." Further components are by-passed to the second machine, where they again form a bank. The first component to reach the machine moves into a pre-load arm, operates a micro-switch, and so signals the start of the machine cycle. Pre-load arm and transfer arm then operate in sequence to load the component into the hobbing machine, where it is clamped hydraulically between centres, the hob rotates, and feed commences. After a pre-determined delay the pre-load arm returns to its start position, ready for the next cycle to commence.

After gear cutting the component is returned to the conveyor by the transfer arm, and by-passes the next machine in the line, which is performing the same operation. To make this by-passing movement the component is placed on the inner track of the conveyor, but it is diverted to the centre track for feeding to the next machining operation. An interlocked stop prevents components from moving along the inner track through the arc of travel of the loading arm, until the arm is safely housed and clear of the conveyor.

### AUTOMATIC GAUGING

On leaving the hobbing machine section of the line the layshafts pass through a Churchill washing machine, which uses a high-pressure chemical spray system to remove all cutting oil and swarf. Air jets dry the components, and they pass via a storage bank to a Churchill Auto-Gauge, to be gauged automatically for size, run-out and lead on all three hobbed diameters. The gauging machine incorporates Sigma gauging heads which advance in sequence to gauge the gears in three successive positions, at 120° angular spacing.

Following the automatic gauging station are three Fellows-England gear shapers, made by Alfred Herbert Limited, Coventry. These machines, which are fitted with Churchill loading arms, cut the second speed gear. They are fed by a conveyor arranged in exactly the same way as that serving the hobbers at the beginning of the line, and each machine has a storage bank section on the conveyor. Washing



*A Fellows-England gear shaper is loaded by a standard Churchill arm.*

and gauging follow the shaping operation, the equipment used being similar to that installed at the end of the hobbing section.

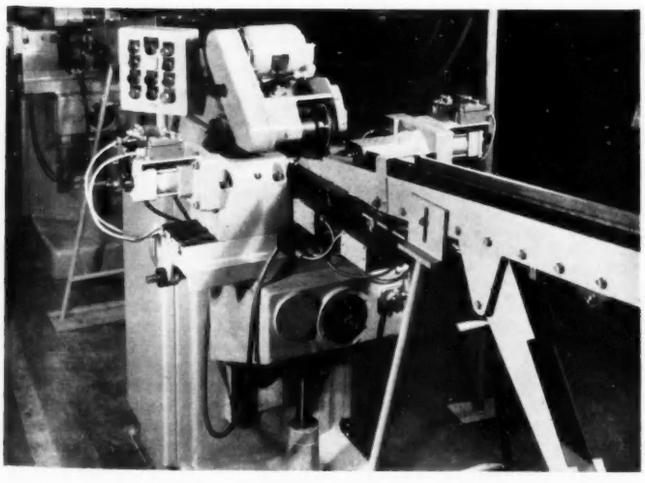
Layshafts pass next to gear rounders and gear chamfering machines, both of Churchill manufacture. On the rounders the component is held by pneumatically-operated head and tailstocks, and is turned by the geared headstock, which at the same time oscillates the table in the correct sequence for tooth rounding. Rapid retraction of the pencil-type cutter enables the components to be loaded and unloaded automatically. The acute edges of the helical gears are removed on the chamfering machines, which are also loaded by standard arms. Storage banks are provided at the rounding and chamfering machines in exactly the same way as at other sections of the line.

Similar conveyors and storage points are provided at the next machines in the line, a group of Churchill gear shavers. Components pass through a washing machine before entering the shavers.

### FINAL CHECKING

After leaving the shaving machines the layshafts are washed and then gauged automatically, all four gears on the shaft coming under test. Any gear failing to pass the gauging is rejected to a separate chute, and if too many gears pass to this chute a signal is given automatically to the machine involved, to stop, pending an investigation of the cause of the fault which has caused the rejections. Finally, the layshafts are loaded into a cylindrical grinding machine made by the Newall Engineering Company Limited, Peterborough, which grinds the outside diameters of the three helical gears on the shaft; these ground diameters serve as datum points after the gears have left the Churchill line and are undergoing subsequent operations.

The production line as built offers many advantages in addition to the obvious one of manpower saving. It is based on standard gear cutting machines and other machine tools, and the conveyors and feed mechanisms are all built up from standard components, so maintenance is simplified. The design itself is flexible, and different lines could be built, incorporating various types of machine according to requirements. Any machine in the line can be stopped at any time for tool changing or other routine maintenance operation without stopping the complete line or affecting the other machines in any way. While the work is being done on one machine the others will continue to operate normally from their stock of components. Damage to components by bruising, which can occur so easily when they are handled between and into machines manually, is eliminated by the mechanical handling equipment in the Churchill line.



*Some operations are carried out with the component axis horizontal, as on this Churchill gear rounder. Components are turned by the conveyors accordingly.*

# SAMPLING INDUSTRIAL DUSTS

An instrument developed in the first place for assessing the dust content of the atmosphere in coal mines is finding increasing applications in precision industries (for instance, gyroscope manufacture) where a clean atmosphere is essential for the production of a satisfactory component.

The Watson British type konimeter, designed in conjunction with the Ministry of Fuel and Power by W. Watson and Sons Limited, Barnet, Hertfordshire, consists essentially of a spring-operated plunger pump, a dust deposition chamber, a glass plate or slide, an air inlet jet and a viewing microscope. The glass slide, which is marked in sectors, can be rotated in stages relative to the air inlet jet and the microscope.

In operation, the glass plate or slide, having been previously treated on one face with a special adhesive, is placed in position on the dust chamber and the retaining ring screwed home.

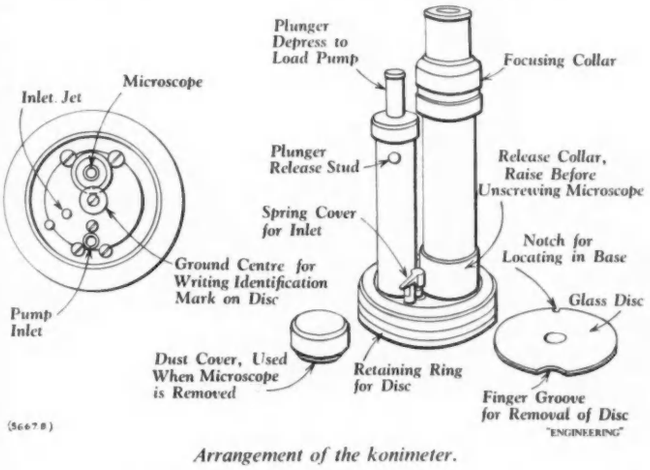
A sample of the atmosphere to be tested is then obtained by depressing the plunger of the pump until it is retained at the lower end of its stroke by an automatic catch. The cover of the air inlet jet is then opened by means of a lever and the plunger is released by pressing a stud on the side of the pump.

A sample of the dust in 5 cc of air will then have been impinged on to that sector of the glass plate opposite the air inlet jet. Further samples may be taken on the remaining sectors of the plate by a similar procedure after rotating the lower half of the dust deposition chamber.

Any required sector of the glass plate may then be brought below the objective of the microscope for examination.

In the original instrument for the National Coal Board, to facilitate evaluation of the dust samples, a graticule fitted to the eyepiece of the microscope has engraved on it intersecting lines forming two angles of 18° each, together with two parallel lines 5 microns apart. The number of particles deposited in both the 18° angles when multiplied by two represents the number of dust particles in each cc of air. Those greater than 5 microns in diameter are ignored. In order to cater for the application where an assessment is required of the size as well as the number of dust particles, Watson are introducing a new form of graticule divided into quadrants, each quadrant having marked on its circumferences dots representing 2, 4 and 6 microns in the plane of the object.

*The Watson British type konimeter for sampling the dust content of air.*




*Arrangement of the konimeter.*

## BIGGER ERW TUBES

Electric resistance welded tubes, hitherto available in this country up to 4½ in outside diameter only, are now being made up to 5½ in diameter, ¼ in wall thickness and in lengths up to 60 ft. A new tube mill, designed by Tube Products Limited, a TI company, has been built at Falcon Works, Wednesfield, Staffordshire, and is producing these larger tubes to British Standard Specifications for various purposes.

## MAKING COMPRESSORS

A colour film has recently been produced for Broom and Wade Limited, High Wycombe, Buckinghamshire, showing the production of their Whirlwind Uniflow oil-flooded rotary compressors. The story is carried through from the pattern being laid in the mould to the unit working on site and includes many interesting shots in the works. A brief pictorial description is given of the method of operation of this type of compressor.

## Book Reviews

# ROCKET

**Missile Engineering Handbook.** By C. W. BESSERER. *D. Van Nostrand Company Incorporated, Princeton, New Jersey, USA.* ($13·50); and *D. Van Nostrand Company Limited, 358 Kensington High Street, London, W.14.* (109*s*)

This book is the fourth in the series on *Principles of Guided Missile Design* under the general editorship of Captain Grayson Merrill. It "is intended as a convenient compendium of the design data which appear in the main series as well as in other unclassified literature," to quote the preface. The publisher's cover comment says that "The guided missile and space flight practitioner will find here the first unclassified complete handbook in this field." Such descriptions, are, in the reviewer's opinion, wishful thinking rather than statements of fact. A great deal of the book is mere makeweight, and much is either irrelevant or is dealt with adequately in university texts or even in school books. The data are extremely poorly referenced.

There are ten sections in the handbook: they are supposed to cover general data, properties of the atmosphere, environmental data and reliability, properties of materials and structures, aerodynamics, "avionics," propulsion, space-flight data, miscellaneous data, and a glossary of terms. If the coverage were good, no one could complain, but some examples of the make-up of the sections will perhaps show that there is room for criticism. Aerodynamics is dealt with in 24 pages, eight of which are taken up with nomenclature and definitions; other topics are the Rankine-Hugoniot and Rayleigh formulae, which are valid only for flow with shock waves: this is only inferred in the case of the Rankine-Hugoniot equation, and not mentioned at all for the Rayleigh formula, which is incorrectly printed and does not have the notation explained. Temperature recovery factors in laminar flow are discussed briefly, and a list of experimental data is given. While the names of the workers and the dates are given, the titles and the publishers of the reports cannot be found. The section ends with a curve showing the temperature achieved by a body at different altitudes up to 1,000,000 ft travelling at 2,610 knots; no explanation is given for the choice of this speed. While no mention is made of methods of achieving stability in the flight of a missile, it is found necessary to give Planck's Radiation Distribution Law in the aerodynamics section.

The section on "avionics" (Aviation Electronics) is noteworthy in that it does not include a single electronic circuit diagram, nor is there any discussion of preferred valve or transistor types; space is found, though, for 12 pages of nomenclature and symbols. In this section are found data on thermal emissivity of a number of substances which include lampblack and bronze radiator paint; in all fairness, it must be noted that the section on general data is equally thoroughgoing, since it has, in the table of densities, data for hickory wood, granite, anthracite, and borax. There are several pages on electromagnetic radiation, antenna systems, radar, and Doppler measurements, but much of this is to be found in text-books and in quite readily available handbooks (such as the excellent *Electronic Designers' Handbook*, by Landee, Davies and Albrecht, McGraw-Hill, 1957).

The section on propulsion takes 35 pages, covering some general data (including for good measure the viscosity of hydraulic fluid) as well as ramjets, turbojets, and solid and liquid propellent rockets. In dealing with "Generalised Rocket Propulsion Equations," the divergence coefficient $\lambda$ for loss of thrust in conical nozzles is mentioned, but there is no indication that $\lambda = \cos^2\left(\frac{\alpha}{2}\right)$, $\alpha$ being the cone semi-angle, although the graph given is the plot of this relation: the divergence angle $\alpha$ is quoted up to 90°, for which it is hardly likely that this simple relation would still hold. These "generalised equations" assume a constant ratio of specific heats in the exhaust gas, and there is no mention that the specific heats are in fact variable or that this has a major effect on rocket-engine performance.

A fairly comprehensive table of liquid propellents is given, but this does not in general indicate the bearing of mixture ratio on performance; for most combinations only one mixture ratio is noted, without comment whether it is stoichiometric or that giving the maximum specific impulse. Some columns of figures are unfortunately transposed, to make it appear that the specific impulse of liquid oxygen with liquid hydrogen is 93 seconds, instead of 363 seconds.

Enough has been said to show that the book is poorly compiled and not always reliable, but mention must be made of the glossary, which occupies nearly one-third of the pages: it must be admitted that there are a number of definitions which were quite new to the reviewer, such as that "a Hartley, in communication, is a unit of information generally defined as being equal to 3·219 bits," but exception must be taken to the definition of heat transfer as "the heat influx of a high speed missile incident to aerodynamic heating," particularly in a work which has passed over rocket design data without mentioning that heating problems exist. The reviewer can find no apt or printable comment for the definition of space simply as "the void between celestial bodies."

In more general terms, the book is a possible source of danger, since the data are not well enough presented to show the limitations of their applications. A surprising feature is the lack of references: this is often accompanied by a failure to show the derivation of a relation, so that the user has no alternative but to take the book on trust in these cases. The reviewer noted only one reference (incomplete), on aerodynamic heating, which might have been to British work. Some use might be found for the tables on mechanical properties of metals and alloys, but these are vitiated for the British reader by the use of United States specification designations, often without giving the interpretation of the specification. Briefly, this book, despite its somewhat massive and authoritative appearance, seems to be aimed at the amateur (perhaps the United States high-school rocketeer) rather than the serious worker, who will do better to save his money and use established texts and data sources.

# NEW BOOKS

**Electric Lifts.** By R. S. PHILLIPS. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, W.C.2.* (63*s*).

Opportunity has been taken in this fourth edition to provide more up-to-date photographs. The previous edition was published in 1951 and most revision will be found in the chapters on "Accommodation" and "Controllers."

**Phenolic Resin Bonded Paper Tube.** Ministry of Supply Reports on Plastics in the Tropics, 9. *Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.* (3*s* 6*d*).

The previous reports in this series have dealt with various types of plastics, and here the tabulated results and commentaries are given on specimens of tube exposed for two years at four sites in Nigeria. Appendices give meteorological data at the stations making it possible to correlate the effects and the atmospheric conditions which may be partly responsible.

**The Performance and Design of Alternating Current Machines.** By M. G. SAY. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, W.C.2.* (37*s* 6*d*).

A third edition, this well-known book on transformers, three-phase induction motors and synchronous machines has been completely revised and converted to M.K.S. units. Much material has been added in the light of modern practice. The book is not intended as a manual for designers; but rather to give an overall picture for the general student.

**Garcke's Manual of Electricity Supply.** Compiled under the supervision of FREDERICK C. GARRETT. *Electrical Press Limited, 19-20 Noel Street, London, W.1.* (80*s*).

One of the virtues of a well-tried book of reference is that it does not depart from a familiar pattern. In its 55th edition "Garcke" has put the newly-formed Electricity Council in the forefront and for the rest remains essentially the same.

**Twenty-First Annual Proceedings of the Railway Fuel and Operating Officers Association, 1957.** *The Railway Fuel and Operating Officers Association, Room 1213, 139 W. Van Buren Street, Chicago 5, Illinois, USA*

These Proceedings include the reports of three committees, a joint session with the Air Brake Association and two panel discussions ("Methods of Teaching Train Rules" and "Diesel Locomotive Operation, Questions and Answers").

# TRADE PUBLICATIONS

*Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.*

### *Power Electricity*

**Rotary Control Switches.** FERGUSON PAILIN LIMITED, Higher Openshaw, Manchester 11. Type RS multi position rotary switches for up to 30A at 440 V or 60A at 250 V a.c. and d.c. Various shapes of handle. Up to 20 circuits with choice of connections. Also type RC control switches with locking handles. Catalogue.

**Motors for the Oil Industry.** METROPOLITAN VICKERS ELECTRICAL COMPANY LIMITED, Trafford Park, Manchester 17. "Electric Motors and Associated Equipment for the Oil and Chemical Industries," 200 page illustrated catalogue covering details and choice of motors and other equipment for use in normal, outdoor, or hazardous situations. Ratings, dimensions and power curves included. Also sections on couplings, bearings and transformers. Publication 7765/2.

**Audio-Frequency Cables.** THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY LIMITED, Mercury House. Theobalds Road, London, W.C.1. Telcon multiconductor and audio-frequency cables, plastics insulated, for junction and trunk working, with and without armour. Dimensions and characteristics. Publication JC/1.

**Motors and Control Gears.** BRITISH THOMSON-HOUSTON COMPANY LIMITED, Rugby. Revised and enlarged edition of the handbook published in 1953 "Installation and Care of Electric Motors and Control Gear." Circuits, faults and power factor information are among items covered. Booklet G.13751/B.

**Crane Control.** LAURENCE, SCOTT AND ELECTROMOTORS LIMITED, Norwich. Revcon crane control system; circuits and details of operation. Publication 125 (3rd edition).

**Handbook.** HIGGS MOTORS LIMITED, Witton, Birmingham 6. "Electricians Pocket Book" gives hints on the installation and maintenance of motors, generators and cables; also power and conversion tables.

**Motor Controllers.** LANCASHIRE DYNAMO NEVELIN LIMITED, Oxted, Surrey. Control gear for a.c. motors; direct-on-line up to 60 h.p. and star-delta up to 100 h.p. List LS2700.

# NAPERIAN LOG

**Men and Machines: A History of D. Napier and Son, Engineers Ltd., 1808-1958.** By CHARLES WILSON and WILLIAM READER. *Weidenfeld and Nicolson, 7 Cork Street, London, W.1.* (35*s*)

The history of Napiers until 1931 was largely the result of the dominance of a family tradition. Founded in 1808 by one of those dour Scotsmen, David Napier, who were settling on the south bank of the Thames and improving their technical skill in the workshop of Henry Maudslay, it remained for most of its independent existence a firm cautiously devoted to precision engineering design and manufacture. Napiers were from the first manufacturers of machinery for Ordnance Factories, although it is interesting, in view of their short but brilliant participation in the manufacture of motor cars, to learn that in 1831 they attempted to manufacture a steam carriage.

Ammunition-making machinery was followed by a great variety of products of which printing machinery was for a time the main speciality, when newspapers were printed on machines which cost between £600 and £700 apiece. The later decision not to advance into the field of rotary machines, which were required when newspapers acquired mass circulations and which would have needed a very much larger production organisation, was typical of the character of the three men who in turn controlled the firm.

James Murdoch, the son of David, who virtually managed it from 1851, displayed that character in an almost caricatured form. A near mechanical genius, proud and honest (except when dealing with the Commissioners of Inland Revenue whose activities fell under the heading of detested Government interference), he had no interest in salesmanship or the commercial side of the firm. He refused to fall in with some of the doubtful practices, particularly in the export trade, of his day. For seven years, up to 1860, no entries were made in the firm's cash book; but that he took so long to find this out is not surprising because he was extremely shy and hardly ever spoke to his employees. He was, however, a stern disciplinarian and when he found out he sacked the accountant. In spite of his hostility to Government interference, he continued the policy of reliance very largely on Government orders.

This policy had enabled David to hand over to him what the authors describe as a "cosy little business" but the new owner, in addition to being a brilliant engineer, was also "an eccentric of over-weening pride" which led him to quarrel with one of his main customers, the Deputy Master of the Royal Mint, after a tour of inspection of foreign mints, on which he had accompanied him. From then until his death his interest in the profits of the firm declined until, by 1885, only seven men were employed making a few expensive special machines for mints and banks and working on the increasingly extravagant ideas of the owner, which were rarely followed up. The workshops in York Road, Lambeth, were full of idle old machines and still employed their own system of screw threads.

J. M. Napier was succeeded on his death in 1895 by his youngest son, Montague Stanley, who bought the moribund business from the executors of his father's will. Immediately afterwards the Locomotives on Roads Act was passed and, less than ten years later, Napiers were the leading motor-car manufacturers in the country. This was the heyday of the Edwardian wealthy class and Napiers made motor cars for those who were able to afford the new and exciting sport. It was, however, the association of Montague Napier with S. F. Edge, the great racing and road trial driver, which added to the excellence of Napier design and workmanship the badly needed spur of enthusiastic salesmanship.

Edge was one of those for whom "automobilism" was something to be pressed forward with an evangelical fervour against all opposition. He it was who realised the importance of road trials and made the Napier the first British car to win the Gordon Bennett Trophy in 1902, and the first car of any make to climb Porlock Hill.

It is a measure of the type of market for which Napiers catered that less than 9,000 vehicles were made in all until motor-car manufacture ceased in 1924, a period in which W. R. Morris was building up his own vast organisation. Although Napiers did once produce a 10 h.p. two-cylindered car which sold for £270, and also, in the years 1909 and 1910, more than 1,000 taxi-cabs in addition to other commercial vehicles, this was not the type of business which they really liked. Not unwillingly, it seems, they were eventually squeezed out from this trade by the more streamlined production and sales organisation of Rolls-Royce above and the growth of the mass producers below.

It was in the 1914 war that they first turned to the speciality on which their reputation has since rested, the design and manufacture of aero-engines; but in 1915 Montague Napier became ill and had to give up formal control of the business, retiring to France in 1917 for the rest of his life. He continued, however, to design for the company and to dominate its policies and he personally developed the famous Lion engine.

The business was now back in the form which Napiers preferred, the design and manufacture on a relatively small scale of specialised goods of superlative quality with the Government as the main source of their business. Naturally, during the war, their output very much increased and they were faced with anxieties about what to do after it. Again, as in the past, the decision went against large-scale production, this time of motor cars, and in favour of sticking to the development of aero-engines. One more high-priced car was produced and its production gave a lot of trouble. This was the period when the weaknesses of the firm became clearer. They only designed what the Air Ministry wanted and took little risk in branching out into lines which would require aggressive salesmanship and productive efficiency to dispose of. Too little was spent on research and development of new products.

Nevertheless, these were great days for Napier engineering; with the Lion engine winning the Schneider Cup in 1927 and helping Seagrave, Campbell and John Cobb to break records on land and Miller and Scott-Paine on water. But the requirements of the last war were to prove too much for the existing management structure. The difficulties in putting the Sabre engine in production, though its design was started in 1935, are well known. Mr. (now Sir George) G. H. Nelson of English Electric was asked by the Government to reorganise the Acton Works in 1942 and this led directly to the end of Napiers as an independent company.

The writing of company histories is made difficult by the fact that in their early years so few records were generally kept and so few of their owners were sufficiently articulate to leave evidence in writing of the nature of their personalities and of their relationships with other people. The authors of this book are economic historians and have not been content with doing a mere public relations job. The social and economic background has been filled in, where detailed information on the firm is lacking. The result is a book of great interest which whets the appetite for more.

# On the Shelf

*By Frank H. Smith*

There is a very strong interest, among the initiated, in aeronautical history and a notable contribution—nay, a classic addition—has been made to the literature by a young Swede named Svante Stubelius. He has prepared a thesis for his Ph.D. at Gothenburg on the origins of aeronautical terms and the first part "Airship, Aeroplane, Aircraft" is distributed by Almqvist and Wiksell, Stockholm, at 25 Swedish Kroner. This 342 page volume is an example of the most patient, painstaking research and, with its forthcoming companion "Balloon, Flying-Machine, Helicopter" should form a complete record of aeronautical etymology for all time.

One notices with pleasure (*Aslib Proceedings*, September, 1958) that the "Aslib Year Book 1958-9" is bound in "a semi-stiff cover of good quality linen in a soft shade of turquoise blue."

The American Institute of Industrial Engineers "is proud to have published the first series of abstracts of research performed in the field of Industrial Engineering," it says. If anybody feels he must contribute to this compilation, write to Research Information Committee, AIIE, at the Department of Industrial Engineering, Washington University, St. Louis 5, Miss.

Somebody on the staff of ENGINEERING (I'm rarely allowed in there so do not know who) has waded through the HMSO "Scientific and Engineering Manpower in Great Britain" and "Standard Industrial Classification" and made a beautiful little chart which is called "Where are the qualified engineers and scientists in British Industry?" Aimed at campaign planners, the figures are also useful for paper-preparers and conversation-promoters (with elbow-benders). I do not think there is any charge (they omit to tell me such details) but judging from a little crafty advertising on the back I feel quite sure that a card to 36 Bedford Street will bring a copy by return.

No. 3 of "LLU News" (a news-sheet of the DSIR Lending Unit, 20 Chester Terrace, London, N.W.1), issued in September, reviews the Russian translation position. The whole business poses all sorts of new problems in information dissemination and DSIR is trying hard to resolve them, and I am quite sure if any user has any bright ideas, DSIR will be glad to have them. For myself, if I get any Russian material I ship it straight off to one of the Government departments who are interested in these things on the understanding that I can have access to it should I require it. The more centralised one can get the files of these peculiarly printed things the greater will be the common good—provided, of course, the central bureau co-operates up to the hilt.

From time to time one comes across people to whom "security" is like fruit salts to water. It makes them froth. To them I would offer a "Symposium on the Literature of Instruments and Instrumentation." This was held in the Library of the British Scientific Instrument Research Association on 6 May by 20 people who included editors of journals devoted to instruments, authors of ditto books and some staff of BSIRA. For some unknown reason, these papers were duplicated as Report M33 and marked CONFIDENTIAL. That was in June. But now, if you pay 10*s* 6*d* to BSIRA at Sira, South Hill, Chislehurst, you can have the papers. And what was all this stuff that was confidential for four months? "How much Literature about Instruments is Published?"; "The Quality and Adequacy of Scientific Literature"; "Buyers' Guides and Directories"; "Where Instrument Literature is Published and How to Find it"; "Knowing of and Finding Publications—Semi-Published Material"; "The Use of Instrument Literature." After hearing that lot I'll bet the assembled editors could hardly wait for the security level to be lowered so that they could tell the world!

**Operation and Maintenance**

# MINE CAR HANDLING PLANT

## *Hydraulically Operated System Installed at Glyncorrwg*

*Fig. 1 Glyncorrwg South Pit, Glamorgan, with the flat concrete roofed building housing the hydraulically operated mine car decking and circulating plant shown to the right. The new installation has a capacity of 2,500 tons per shift.*

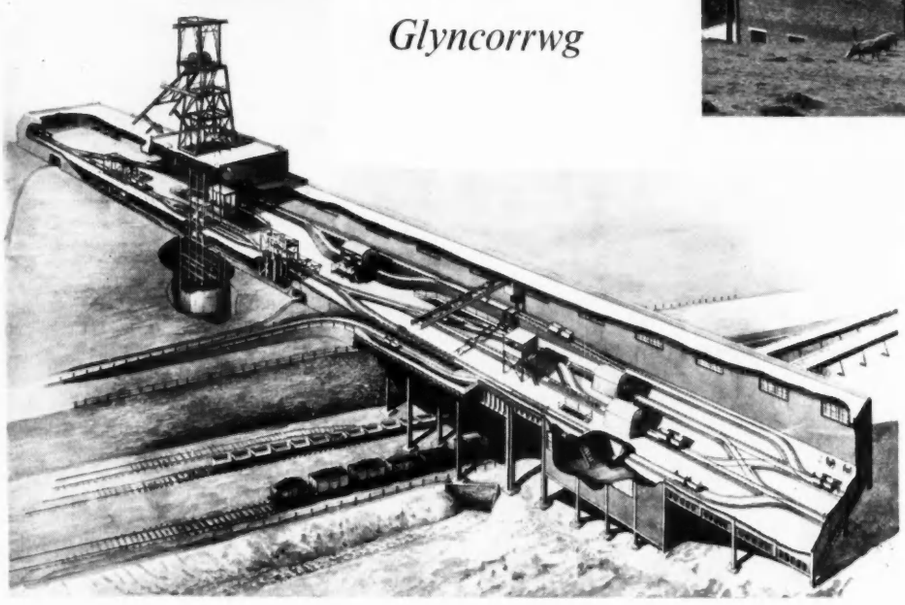


*Fig. 2 An artist's impression of the two-man controlled decking and circulating plant showing the location of the double deck cages, lifts, tipplers, and control cabins.*

*Fig. 3 The tippler end of the circuit showing the control bridge attendant's cabin, coal and dirt discharge stations, and motor driven chain creepers.*

As part of a modernising programme carried out by the National Coal Board at the Glyncorrwg South Pit, Glamorgan, a hydraulically operated mine car decking and circulating plant has been built by Humphreys and Glasgow Limited, 22 Carlisle Place, London, S.W.1.

The new installations, which include electrically wound pithead gear, have a capacity of 2,500 tons per shift with simultaneous decking of double deck cages, the winding time per cage being 50 seconds with 10 seconds allowed for decking. This compares with 900 to 1,000 tons per shift before modernisation, when single deck cages were used and the empty tubs were decked by manual labour.

A general view of the colliery is shown in Fig. 1. The flat concrete roofed building enclosing the pit top decking system is shown to the right of the illustration and is carried by plate girders which span a narrow valley through which run a railway line, and also a stream in a culvert. The steel framework is of rigid frames, site welded and with bolted trimmers supporting the brickwork panels, concrete floors and roof; two flexible joints were provided in the framework to allow for thermal expansion and possible subsidence. Reconstruction work started in autumn 1955 and proceeded without interrupting production, the changeover to the new mechanical handling system taking place during the holiday period, August 1957.

### TWO MAN CONTROL

The equipment was designed to handle 1½ ton capacity mine cars coupled in pairs throughout the circuit. Movement of the cars and such operations as banking, shunting, tipping and cleaning are automatically controlled by two men—the banksman and control bridge attendant—from control desks in separate cabins conveniently located. An artist's impression of the general layout is shown in Fig. 2.

A hydraulic system of control was recommended by Humphreys and Glasgow, in preference to the more conventional pneumatic systems. This was based on the firm's experience of this type of equipment on their water-gas plants; the points in favour of hydraulic operation being smooth and positive control, elimination of the risk of freezing in cold weather, minimum maintenance, and less severe wear and tear on the mine cars. The hydraulic components comprising pumps, reservoirs, rams and control valves were supplied by Keelavite Hydraulics Limited, Allesley, Coventry, Warwickshire.

The method of operation with this mine car decking and circulating plant is as follows. On arrival at the decking levels, the shaft gates at at both levels are opened and the cage hydraulically aligned ready for the discharge of the cars. To do this, catches in the cage are lowered, and stops in front of the cage are lowered to enable decking rams on each level to ram empty cars into the cage, pushing out the full cars while

the empty cars are held in the cage by shuttle stops. At the upper banking level, which is the main operating level, the two full cars travel along the line and over the upper deck of an hydraulic lift. This is subsequently used to raise the two full cars from the lower level, which are checked by an hydro-pneumatic retarder before reaching the lower deck of the lift. The operation of this lift is controlled by means of an axle counter which raises the lift when the high level cars have passed over the upper deck and lowers it when the low level cars have run clear. From this point all the cars pass over a retarder which slows them down to a speed of one foot per second before reaching a set of points which are actuated by the banksman. According to the setting of these points, the cars are either sent to their discharge positions or out of the building via a motor driven chain creeper acting as a retarder and a hydraulically raised gravity shuntback up which the cars run and then gravitate out of the building over spring points.

## DISCHARGING WITH ROTARY TIPPLERS

The cars proceeding to discharge positions pass over a further set of points, under the bridge attendant's control, which direct the cars either to coal or dirt discharge stations (Fig. 3). In both cases they pass over hydro-pneumatic retarders before being stopped in front of the rotary tipplers. Entry into the tipplers is controlled by the control bridge attendant, whose cabin overlooks the whole of this end of the building. A pair of cars is held until the tippler is in line and then, with the front stop lowered, they are rammed into the tippler. When the ram reaches the full extent of its stroke it is automatically reversed and on its return operates to raise the front stop while lowering a rear stop to allow a further pair of cars to gravitate into position against the first stop. The tipplers, with a pair of cars in position, are then rotated to discharge the coal or dirt into an apron feeder, directly beneath the tippler, on a lower floor of the building. The apron feeder at each discharge station feeds the mine car contents on to a belt conveyor, one serving the coal tippler and another the dirt tippler, which carries the coal or dirt away from the circuit building.

After discharging their contents, the empty cars are pushed out of the tippler as the next pair of full cars are rammed into position. The whole sequence of operations, that is, entry of cars, tippling and discharge of empty cars, proceeds automatically when the control bridge attendant starts the hydraulically controlled tippler loading rams. If required, however, the tippling can be manually controlled by separate start and stop buttons. The apron feeders are electrically interlocked with the conveyors so that the feeders cannot be started until the conveyors are running.

From the tipplers the empty cars run down the track towards the end of the building and from there are normally returned towards the pit-head by means of a hydraulic shuntback. If required, however, the cars can be diverted to another track and sent out of the building by means of a second hydraulic shuntback. These shuntbacks are so designed that the rams are normally fully extended with virtually no pressure on the pistons; when two cars strike the ram head, the ram is pushed back into its cylinder for a pre-determined distance, after which a valve is operated which loads the ram to decelerate and stop the cars before accelerating them in the opposite direction.

## RETURNING THE EMPTY CARS

The cars returning to the pit-head are elevated approximately 7 ft by means of a motor driven chain creeper 60 ft long. They then gravitate towards the pit shaft, their speed being controlled by hydro-pneumatic retarders. A diversion loop is provided in this part of the circuit leading to another rotary tippler operated by push buttons from a platform alongside; this can be used as an extra dirt tippler and also as a car cleaning tippler. To clean the cars, rotary brushes are moved into each car separately and moved along and up and down the surface; after the cleaner has been withdrawn, the tippler is rotated to discharge the dirt into waiting tubs on the lower banking level.

The pairs of empty mine cars which have travelled towards the pit-shaft end of the building, either directly or through the car cleaner tippler are now marshalled for ramming into the cages. At this end of the building is a waiting section or "sluice" between a pair of stops which control entry and exit. Beyond the sluice the mine cars pass over spring points against a hydraulic shuntback which reverses their direction and sends them towards a stop in front of a lift. This sequence of operations is automatically controlled so that cars are only allowed to leave the sluice when no cars are waiting outside the hydraulic lift. The charging of the "empties," lift, and the decking operations are synchronised under the control of the banksman, the lift being in its normal lowered position with a pair of cars on each deck. When the cage is aligned with the stops on the "empties" side raised the points are set and stops in the cage are lowered to allow the two pairs of cars in the lift to gravitate to the front of the lift, ready to be rammed out of the lift so that the whole decking cycle can re-commence.

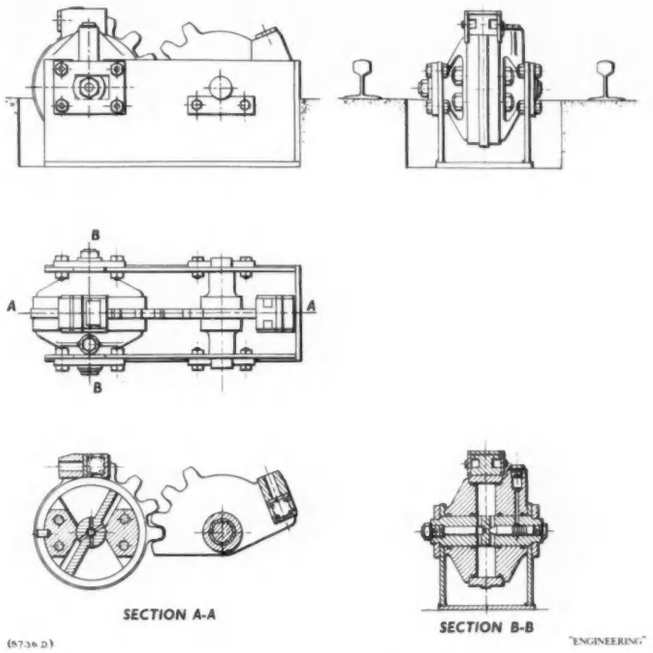



*Fig. 4 Details of mine car retarders designed by Humphreys and Glasgow Limited. Only two moving parts geared together apply hydraulically controlled retarding forces to dummy axles of the mine cars.*

## HYDRAULIC EQUIPMENT

Five Keelavite positive displacement gear type hydraulic pump units are provided. Two units are installed at the tippler end of the building, and three units with a similar tank are located at the shaft end of the building. In the latter case one of the units supplies the pressure to the two upper level decking rams and the lift on the outgoing side, while another supplies the pressure to operate the lift on the return side and the two lower level decking rams. The third unit comprises a servo double pumping unit and supplies all the main auxiliaries such as car stops, cage gates, keps, points and shuntbacks. The oil from this unit is continuously filtered before returning to the tank. At the tippler end of the building, one unit supplies the pressure to the tippler loading rams and a double unit supplies the pressure for the remainder of the system at this end of the building.

The stops and retarders incorporate a hydro-pneumatic cylinder to absorb the energy. These cylinders work on the principle that the energy is absorbed by the constant reaction of a ram over a specified stroke displacing oil through a progressively closing orifice. Air displaced in the system is used to return the buffer ram to the beginning of its stroke. The cylinders are completely self-contained and do not normally require any external piping. By varying the rate at which the oil is displaced the constant reaction can be altered, and thus the speed at which the cars leave the retarders can be changed.

When the mine car circuit was commissioned it was found that the cars ran too fast on one section of the track before the rubbish tippler. Humphreys and Glasgow therefore designed a self contained retarder for the purpose, which by acting on all the dummy axles of the mine cars can provide continuous retardation over 10 ft (Fig. 4). As each axle passes through the retarder the first moving component is turned approximately 60° during which the car advances under controlled retardation and up to a set limit. This same axle passes to the second moving component which is geared to the first and a further operation takes place driving the oil in the reverse direction and bringing the first component to its original position ready to receive the second axle of the car. Four distinct retardations are therefore applied to each car. When the cars are coupled there are eight retardations during an advance of 10 ft. The controls provided, one limits the retarding force on the axle to prevent derailment or damage, and another sets the outgoing speed of the cars. Since there are only two moving parts, each on a heavy shaft, little maintenance is required.

*Continuing*

**Operation and Maintenance**

# PREPACKING FRESH FRUIT AND VEGETABLES

Over the last four years the prepacking of fresh fruit and vegetables has increased from 100,000 prepacks (of average weight 1 lb) to well over 180 million, sold annually. The development of this industry was described in a paper "Prepacking of Fresh Fruit and Vegetables," by C. H. Stansfield, read at the October conference on Prepacking of Fruit and Vegetables. Parts of this paper are reproduced below.

There are now over 300 firms prepacking in this country. Some of them deal only with seasonal crops and often handle only one product. Others are engaged in general prepacking and handle various products in season, imported as well as home-grown. Apart from isolated instances, it was not until 1950 that prepacks began to appear in small quantities for packing-houses specially set up for the purpose.

Prepacking can take place at any one of a number of points in the chain of distribution linking farmer and consumer, but naturally, to secure economic operation, the packing-houses are wherever possible sited where the crop is grown, either at the farm itself and operated by the farmer, or at a packing-house owned by a country merchant elsewhere.

Potatoes are a good example of a crop particularly suited to localised packing. The packing-houses are usually run by potato merchants' who have their own wholesale outlets and can be assured of a continuous supply through their trade contacts. Not least, they have also the capital necessary to instal high throughput machinery. Output varies enormously. The majority operate at the rate of 100-150 tons per week but individual packing-houses process from 25 tons to 300 tons per week. The disadvantage of packing in the production area is that work tends to be on a seasonal basis. On the other hand, the disposal of waste material and of low-grade produce unsuitable for prepacks is easier at this stage.

There are three main types of prepack—the bag, the carton, and the direct overwrap—their use depending on the value of the produce and the degree of protection required. Thus bag packing is the most popular for root crops and for produce which does not damage easily. Various types of cartons (often covered with transparent film) have been devised for particular crops, but are generally reserved for the more expensive ones and those needing some protection: for example apples, tomatoes and mushrooms. Fibre-board trays make a useful base for produce that is to be overwrapped. This form of packing is also reserved for the more expensive fruits.

Polyethelene film is the most popular material for bags. In addition, cellulose films, kraft paper, net and mesh containers are used. Recently, polyethelene net in sleeve form has become popular. The produce is fed into it and the packs formed by cutting and sealing the ends.

The method of closing bags largely depends on the material used. The commonest method of sealing a polyethelene bag is by stapling, with or without header labels, others use wire strip fasteners, tapes which may be gummed or are pressure sensitive, and heat-sealing.

Mechanisation in prepacking has developed greatly during the past two years. Packing-houses today have the appearance of factories, and indeed factory methods are used to achieve the high degree of efficiency required to turn out large quantities of uniform packages. New machines have been developed to handle horticultural produce and the three main methods of mechanical packing which have been evolved are the bagging machine, the return-flow belt system and the overwrapper.

Bagging machines are semi-automatic or fully automatic, in that they weigh a given quantity of produce which can be tipped into a bag. One of the latest types makes its own bags from a reel of ployethelene sleeving, automatically weighs the correct amount of produce, and fills the bag. Flow-return systems consist of two counter-travelling conveyor belts on which a constant stream of produce passes the weighing operators.

Overwrapping machinery of the fully automatic type used for other food products for many years has been adapted for overwrapping cartons of horticultural products. Such equipment is very expensive and a high rate of output must be achieved if the capital cost is to be justified. Semi-automatic overwrappers and sleeve wrappers have also been installed for carton packing, particularly by the specialist apple packers.

Washed potatoes are becoming more and more popular, and it has been estimated that 10-15 per cent of prepacked potatoes were washed during 1957-58. Vegetable washing machines followed by heat dryers have been incorporated in the prepack line. Dry brushing of potatoes is also practised, particularly if the crop is grown on a soil which can easily be removed by this method.

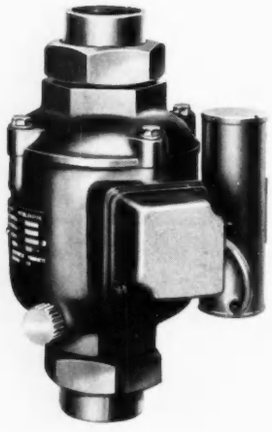
**Engineering at Home**

# PUMP FOR PIPING

Precision Electrical Products (Stockport) Limited, Progress Works, Cale Green, Stockport, have concluded an agreement with Plumettaz S.A. of Bex, Vaud, Switzerland, to manufacture the range of Plumett glandless heating accelerators. The Plumett is a small pump that can fit easily into pipework without altering the line of run. A view of the device is shown in Fig. 1 and a cross-sectional drawing is given in Fig. 2.

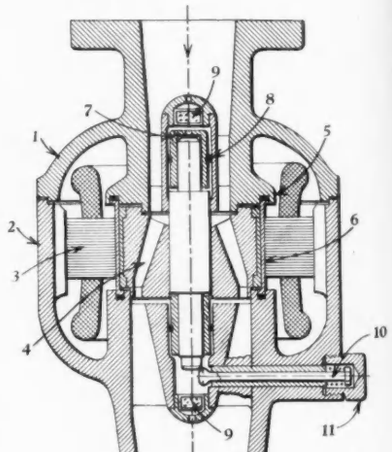
The internal path of the water through the pump is unaltered, and when the pump is installed vertically any foreign bodies in the water will tend to fall through the rotor without sticking. A small device that enables the direction of rotation of the pump to be checked may also be used to free the rotor manually should it be jammed. The rotating element is supported in water-lubricated self-aligning bearings equipped with filters. This patented feature is intended to eliminate trouble likely to be caused by stresses in the pipework due to expansion, or faulty alignment of the flanges during installation.

The compactness of the Plumett is achieved by building the pump and motor as one integral unit. The construction is most easily described by considering an electric motor in which the rotor has been hollowed out along its central axis and a propeller installed. In this way the bulk of both pump and motor is enclosed in a common body and the weight distributed equally around the central axis. Standard Plumetts are available for from 1·5 to 3 in branch connections, at prices ranging from £26. For special applications a high head model is available.



*The Plumett pump is of small size and fits easily into a run of piping.*

*The construction of the pump is basically that of an electric motor with a hollow rotor in which a propeller has been fitted.*




(5729.B) "ENGINEERING"

1. Inlet casing.
2. Body.
3. Stator.
4. Rotor.
5. Joint.
6. Sleeve.
7. Floating bearings.
8. Centering ring.
9. Filter.
10. **Rotating indicator.**
11. **Knurled cap.**

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